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Phase 2 Geoscientific Preliminary Assessment

Acquisition, Processing and Interpretation of High-Resolution Airborne Geophysical Data

TOWN OF BLIND RIVER, CITY OF ELLIOT LAKE AND AREA, ONTARIO



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PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT**ACQUISITION, PROCESSING AND INTERPRETATION OF
HIGH-RESOLUTION AIRBORNE GEOPHYSICAL DATA****THE ELLIOT LAKE AND BLIND RIVER AREA, ONTARIO****Prepared for:****Nuclear Waste Management Organization (NWMO)****by:****Sander Geophysics Limited (SGL)****NWMO REPORT NUMBER:****APM-REP-01332-0217**

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Executive Summary

This technical report documents the results of the acquisition, processing and interpretation of high-resolution airborne geophysical data conducted as part of the Phase 2 Geoscientific Preliminary Assessment, to further assess the suitability of the Elliot Lake and Blind River area to safely host a deep geological repository (Golder, 2017). This study followed the successful completion of a Phase 1 Geoscientific Desktop Preliminary Assessment (Golder, 2014). The desktop study identified 3 potentially suitable areas warranting further studies such as high-resolution surveys and geological mapping one of which was covered by the survey.

The purpose of the Phase 2 acquisition, processing and interpretation of geophysical data was to provide an updated interpretation of the geological characteristics of the potentially suitable bedrock unit identified in Phase 1 and to provide additional information to further assess the geology of the Elliot Lake and Blind River area. Both magnetic and gravimetric data were acquired during the survey in order to provide data to interpret the geometry and thickness of the potentially suitable bedrock units; the nature of geological contacts; bedrock lithologies; the degree of geological heterogeneities and the nature of intrusive phases within the area; as well as the nature of structural features such as faults, shears zones, and alteration zones. The grids of the acquired magnetic and gravimetric data and associated processed grids (first, second and horizontal derivatives, total gradient amplitude, trend analysis solutions and tilt angle) were analyzed and interpreted together with the mapped bedrock geology and other available geological information (e.g. magnetic susceptibility and rock density).

The survey allowed for a characterization of the local gravity and magnetic signature of the granite-granodiorite suite of the Ramsey-Algoma granitoid complex and the transition to the gneissic tonalite suite to the north. A gravity low at the southern end of the survey either represents the deepest portion of a uniformly dense granite-granodiorite suite or a local alternate phase of emplacement with a slightly lower density than the rest of the granite-granodiorite suite. A gravity high at the northern end represents a dipping transition from the granite-granodiorite suite to a denser gneissic tonalite suite. Low amplitude long wavelength variations in magnetic anomalies highlight some degree of lithological heterogeneity within the granite-granodiorite suite.

The gravity and magnetic signature of the Benny Lake greenstone belt shows internal compartmentalization with variations in magnetic properties and a possible extension of the greenstone belt farther to the west of the mapped area.

Preliminary forward modelling was completed on two profile lines covering the local features of the Ramsey-Algoma granitoid complex and intrusions and greenstone belts within the study area. Multiple model options looking at either uniformly or variably dense granite-granodiorite rocks were investigated. The base of the Ramsey-Algoma granitoid complex has been modelled no shallower than 5 km below Mean Sea Level (MSL) in all scenarios.

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1 Introduction

This technical report documents the results of the acquisition and interpretation of high-resolution airborne geophysical data (gravity and magnetic) conducted as part of the Phase 2 Geoscientific Preliminary Assessment, to further assess the suitability of the Elliot Lake and Blind River area to safely host a deep geological repository (Golder, 2017). This study followed the successful completion of a Phase 1 Geoscientific Desktop Preliminary Assessment (Golder, 2014). The desktop Phase 1 study identified 3 potentially suitable areas warranting further studies such as high-resolution surveys and geological mapping located within the Ramsey-Algoma granitoid complex one of which is covered by this study.

1.1 Study Objective

The main purposes of the acquisition and interpretation of high-resolution magnetic and gravity data are as follows:

- Acquire high-resolution airborne magnetic and gravimetric data within a geophysical survey area that encompasses parts of the Ramsey-Algoma granitoid complex identified in the Phase 1 Geoscientific Desktop Preliminary Assessment (Golder, 2014).
- Characterize the geophysical response of the bedrock units (e.g. bedrock contacts, intrusive phases, potential natural resources, etc.).
- Characterize the extent of bedrock heterogeneity (e.g. ductile fabric, complexity, etc.).
- Interpret the geophysical character of potential structures (faults, dykes, joints, etc.).
- Develop initial models of bedrock units at depth (2.5D forward modeling).

1.2 Geophysical Survey Area

Elliot Lake is located east of Sudbury and west of Sault Ste. Marie just north of the intersection of Highway 17 and Highway 108. The Elliot Lake and Blind River survey block is located approximately 50 km to the northeast of Elliot Lake and encompasses an area of just over 1,600 km².

The location of the geophysical survey area is shown in Figure 1.1 overlying the bedrock geology, and the full set of survey lines are shown in Figure 1.2. The geophysical survey area is bounded by the coordinates presented in Table 1.1 (NAD-83 datum, UTM zone 17N).

Table 1.1: Coordinates of the survey area (NAD-83, UTM 17N)

Easting (m)	Northing (m)
Elliot Lake and Blind River Block	
389574	5206150
422518	5206248
422715	5176066
405750	5175967
398773	5192100
392993	5194735
389574	5206150
389574	5206150
422518	5206248

2 Summary of Geology

Details of the geology of the area were described in the Phase 1 Geoscientific Desktop Preliminary Assessment (Golder, 2014). The following sections provide brief descriptions of the geologic setting, bedrock geology, structural history and mapped structures, metamorphism and Quaternary geology of the area. The focus of the following sections are the bedrock units identified during Phase 1 as being potentially suitable to host a deep geological repository and the important structural features in the area.

2.1 Geological Setting

The area is located within the Archean Superior Province of the Canadian Shield. The Superior Province is a stable craton created from a collage of ancient plates and accreted juvenile arc terranes that were progressively amalgamated over a period of more than 2 Ga (e.g., Percival et al., 2006). The Superior Province covers an area of approximately 1,500,000 km² and is divided into subprovinces, including the Abitibi Subprovince within which the area is located.

The Abitibi Subprovince is bounded to the west by the Kapuskasing structural zone and Wawa Subprovince and to the north by the Opatca Subprovince. Its southern boundary is overlain by metasedimentary and metavolcanic rocks of the Huronian Supergroup of the Southern Province. The Abitibi Subprovince developed between ca. 2.8 and 2.6 Ga (Thurston, 1991) and comprises multiple units of volcanic and associated metasedimentary rocks (greenstone belts) separated by extensive granitic plutons and batholiths. These greenstone belts typically occur in elongate geometries and represent a significant percentage of the rocks in the northern portion of the subprovince, while occurring less so in the southern portion of the subprovince. The surrounding granitoid bodies are composed primarily of tonalite to granodiorite, and represent the vast majority of the rocks present throughout the area.

Six generations of Proterozoic diabase dyke swarms, ranging in age from ca. 2.473 Ga to 590 Ma intrude the bedrock units in the area (Krogh et al., 1987; Kamo et al., 1995; Buchan et al., 1996; Hamilton et al., 2002; Buchan and Ernst, 2004).

2.2 Bedrock Geology

The Abitibi Subprovince is composed of low metamorphic grade volcanic rocks and granitoid plutonic and gneiss-dominated rocks, the latter of which are predominant in the area and are represented by the Ramsey-Algoma granitoid complex (e.g., Jackson and Fyon, 1991).

The Ramsey-Algoma granitoid complex is a large heterogeneous group of granitoid bodies that intruded the older metavolcanic and subordinate metasedimentary rocks of the Whiskey Lake and Benny Lake greenstone belts. The vast majority of the area is underlain by the Ramsey-Algoma granitoid complex (see Figure 1.1 and Figure 1.2), which extends beyond the study area in all directions. Less extensive lithological unit of the area comprises a thin sliver of the westernmost portion of the Benny Lake greenstone belt (see Figure 1.1 and Figure 1.2).

Several generations of Proterozoic diabase dyke swarms, ranging in age from 2.473 Ga to 590 Ma, cut all bedrock units in the area. The most prominent of these dyke swarms include the northwest-trending Sudbury swarm, ca. 1.238 Ga (Krogh et al., 1987); the north-northwest-trending Matachewan swarm, ca. 2.473 Ga (Buchan and Ernst, 2004); and the north-trending Marathon dyke swarm, ca.

2.121 Ga (Buchan et al., 1996; Hamilton et al., 2002). Less numerous dykes belonging to the northeast-trending Biscotasing, ca. 2.167 Ga (Hamilton et al., 2002), west-northwest-trending North Channel, ca. 1.6 to 2.5 Ga (OGS, 2011), and east-northeast-trending Grenville, ca. 590 Ma (Kamo et al., 1995) dyke swarms also crosscut the area.

The main geological units of interest occurring in the area are further described below.

2.2.1 Ramsey-Algoma Granitoid Complex

The Ramsey-Algoma granitoid complex is a large complex of granitoid and gneissic rocks divided in three large domains: the Chapleau gneiss, Ramsey gneiss and Algoma plutonic domains (Jackson and Fyon, 1991). In the area, the granitoid complex is dominated by the Algoma plutonic domain. Although some portions of the Algoma plutonic domain have been mapped in detail (e.g., Robertson, 1965a,b,c; Robertson and Johnson, 1965; Giblin, 1976; Giblin et al., 1977), the Algoma plutonic domain remains poorly studied. The Ramsey-Algoma granitoid complex is generally described in the literature as consisting largely of a massive to foliated granite-granodiorite suite intruding a tonalite-granodiorite suite. In addition, several narrow slivers of metavolcanic rock are commonly mapped within the gneissic tonalite portion of the Ramsey-Algoma granitoid complex. In the study area, however, these rocks are observed within the massive granodiorite to granite suite.

The Algoma plutonic domain consists of granitic and granodioritic rocks and granitic gneisses with numerous greenstone enclaves and massive to foliated granite, granodiorite, and syenite intrusions (Card, 1979). In the area of Rawhide Lake, approximately 15 km north of Elliot Lake, the Algoma plutonic domain consists generally of uniform, massive, medium to coarse-grained, equigranular granite (Ford, 1993). Approximately 45 km northwest of Elliot Lake, in the area of Kirkpatrick Lake, the plutonic complex is reported to be predominantly composed of massive to foliated biotite-bearing to hornblende-bearing granitic rock. Minor, more leucocratic phases are typically quartz monzonite to granodiorite and trondhjemite. In the Wakomata Lake area, approximately 30 km northwest of Blind River, outcrops of pink to grey, equigranular, fine- to coarse-grained trondhjemite, quartz monzonite and granodiorite have been reported, of which grey, medium- to coarse-grained, leucocratic trondhjemite predominates (Siemiatkowska, 1977). Sage (1988) described granitic rock in the Seabrook Lake area (65 km northwest of Blind River) as massive, medium- to coarse-grained, red to red-brown, leucocratic, and granodiorite to quartz monzonite. In the area of East Bull Lake (25 km east-northeast of Blind River), Easton et al. (2004) reported mixtures of strongly foliated granitic gneiss and migmatitic facies enclosing mafic gneiss, whereas McCrank et al. (1989) described that area as comprising weakly to moderately foliated granodiorite and porphyritic granite. Lastly, Gordon (2012) noted massive, homogeneous syenogranite as the main plutonic phase in Otter Township, west of the study area.

Geochronology for the Algoma plutonic domain includes an age of ca. 2.716 Ga (billion years) in the Batchawana area, approximately 60 km west of Blind River and Elliot Lake (Corfu and Grunsky, 1987), and ca. 2.662 Ga for the area south of Ramsey, about 50 km north of the area (van Breemen et al., 2006). Heather et al. (1995) reported a preliminary age of ca. 2.727 Ga for biotite tonalite from immediately south of the Swayze greenstone belt approximately 60 km northeast of the area. More recently, Easton (2010) obtained preliminary dates of ca. 2.675 and 2.651 Ga for two samples of granite and granodiorite near Elliot Lake. The wide range of dates suggests that the Ramsey-Algoma granitoid complex contains distinct plutonic and gneissic lithologies emplaced over a period of 75 Ma (million years) and possibly longer. This interpretation is supported by van Breemen et al. (2006) who subdivided granitic rocks in the Swayze area, approximately 120 km north of Elliot Lake, into the

following five broad categories:

- Synvolcanic diorite and hornblende tonalite intrusions ranging in age from ca. 2.740 to 2.696 Ga.
- A transitional suite of tonalite and quartz monzonite intrusions ranging from ca. 2.695 to 2.686 Ga.
- Syntectonic hornblende granodiorite intrusions ranging from ca. 2.685 to 2.686 Ga.
- A younger transitional suite of tonalite and quartz monzonite intrusions ranging from ca. 2.680 to 2.665 Ga.
- Non-foliated ca. 2.665 Ga post-tectonic granite intrusions occurring within areas of synvolcanic and syntectonic intrusions.

Although the Swayze area is located further north, it shares a similar tectonic setting to the northern part of the area. Van Breeman et al. (2006) may therefore offer an interpretative framework for the largely unmapped Ramsey-Algoma granitoid complex within the area. Heather et al. (1995) also described a large body of massive Algoma biotite granite in the area southwest of Ramsey, approximately 50 km north of the assessment area.

2.2.2 Benny Lake Greenstone Belt

The Benny Lake greenstone belt consists of Archean metavolcanic and metasedimentary rocks that form a 40 km long by 5 km wide east-striking greenstone belt extending from the Geneva Lake area to the Mink Lake area, some 70 km northeast of Elliot Lake. The greenstone belt extends only 4 km into the area (see Figure 1.1 and Figure 1.2) to its mapped termination south of Mink Lake. Card and Innes (1981) described the central part of the greenstone belt as consisting of intercalated mafic flows and pyroclastic rocks with intermediate tuffs and tuff-breccia with some volcanogenic metasedimentary rocks including tuffaceous greywacke and siltstone, chert, and iron formation. The stratigraphic sequence in this part of the belt comprises cyclic repetitions of mafic, intermediate, and felsic metavolcanics, plus sulphide-bearing tuffs and tuffaceous metasedimentary rocks that commonly lie along contact zones between the metavolcanic units.

Felsic plutonic rocks are noted to surround and intrude the greenstone rocks. Card and Innes (1981) subdivided these rocks into an older gneissic, granodioritic complex that occurs mainly to the north of the greenstone belt and a younger, relatively massive, homogeneous quartz monzonite that forms most of the terrain to the south. Although there is no published information on the age of the Benny Lake greenstone belt, Easton (2010) noted that the ages obtained for the Whiskey Lake greenstone belt, located approximately 50 km to the southwest, were consistent with ca. 2.690 to 2.685 Ga volcanism in the southern part of the Abitibi Subprovince.

The greenstone sequence dips steeply to the south with a schistosity subparallel to the primary stratification. Movements on major northwest and north-northwest trending faults such as those along the Spanish River have resulted in progressive northward displacement of the Benny Lake greenstone belt from east to west (JDMA, 2014a).

2.2.3 Mafic Dykes

Six generations of Proterozoic diabase dyke swarms crosscut the area (Buchan and Ernst, 2004). The generations of dyke swarm include:

- North-northwest-trending Matachewan Suite dykes (ca. 2.473 Ga; Buchan and Ernst, 2004). This dyke swarm covers the largest area through the Canadian Shield and is predominant in the area. Individual dykes are generally up to 10 metres wide, and have vertical to subvertical dips. The Matachewan dykes comprise mainly quartz diabase dominated by plagioclase, augite and quartz (Osmani, 1991).
- Northeast-trending Biscotasing Suite dykes (ca. 2.167 Ga; Hamilton et al., 2002). The dykes form prominent northeast trending regional features, with individual dykes typically 50 to 100 metres in width. The Biscotasing dykes are quartz tholeiitic features with fine-grained chilled margins and medium- to coarse-grained interiors (Buchan et al., 1993; Halls et al., 2008), dominated by plagioclase, pyroxene and quartz with minor magnetite-ilmenite intergrowths. These dykes are rare in the area.
- North-trending Marathon Suite dykes (ca. 2.121 Ga; Buchan et al., 1996; Hamilton et al., 2002). These form a fan-shaped distribution pattern around the northern, eastern, and western flanks of Lake Superior, and are relatively uncommon in the area. The dykes vary in orientation from northwest to northeast, and occur as steep to subvertical sheets, typically a few metres to tens of metres thick, but occasionally up to 75 metres thick (Hamilton et al., 2002). The Marathon dykes comprise quartz diabase (Osmani, 1991) dominated by equigranular to subophitic clinopyroxene and plagioclase.
- West-northwest-trending North Channel dykes (ca. 1.6 to 2.5 Ga; OGS, 2011). This dyke swarm may be temporally associated with the ca. 1.884 Ga Molson dyke swarm in Manitoba, and the Wabigoon dyke swarm in northwestern Ontario (OGS, 1997; Buchan and Ernst, 2004). These dykes are rare to absent in the area.
- Northwest-trending Sudbury Suite dykes (ca. 1.238 Ga; Krogh et al., 1987). Individual dykes are generally less than 10 metres wide, and appear to have intruded into older northwest-trending faults (Easton, 2009). Sudbury dykes typically range in composition from olivine diabase, amphibole diabase, diabase, magnetite-bearing diabase to lamprophyre.
- East-northeast-trending Grenville dykes (ca. 590 Ma; Kamo et al., 1995). Within the Superior Province these dykes are parallel to the Ottawa graben, and individual dykes are generally less than 15 metres in width. These dykes are rare to absent in the area.

Within an aeromagnetic data set, the dyke swarms in the area are generally distinguishable by their unique strike directions, cross-cutting relationships and, to a lesser extent, by the amplitude of the associated magnetic anomalies.

2.3 Structural History

The structural history of the area is complex. Investigations within the study area and its vicinity conclude that the region has undergone complicated polyphase deformation (e.g., Card et al., 1972; Young, 1983; Riller et al., 1999; Jackson, 2001; Easton, 2005). The most comprehensive studies on the structural geology of the area and its vicinity have been carried out by Zolnai et al. (1984), Riller et al. (1999) and Jackson (2001). These and other investigations documenting the structural geology of

particular portions of the area (e.g. Easton, 2005) support the presence of up to three main deformation orogenic phases which have overprinted all bedrock lithologies, and have been assigned to the Blezardian, Penokean, and Grenville orogenies. It should be noted, however, that the occurrence of the Penokean Orogeny in the area remains controversial (e.g. Davidson et al., 1992; Piercey et al. 2003), and evidence for the Grenville Orogeny is scarce. As the aforementioned studies were performed at various scales and from various perspectives, the following summary of the structural history of the area should be considered as a best-fit model that incorporates relevant findings from all studies. The structural history of the area is described below and summarized in Table 1.1.

It is understood that there are potential problems in applying a regional deformation numbering (D_x) system into a local geological history. Nonetheless, the following summary offers an initial interpretation for the area, which may be modified in the future if site-specific information is collected.

The earliest deformation phase (D₁) is associated with ca. 2.72 to 2.7 Ga penetrative deformation of rocks of the Whiskey Lake and Benny Lake greenstone belts. According to Jensen (1994), this penetrative deformation is represented by foliation closely paralleling the strike and dip of the metavolcanic and metasedimentary strata composing the greenstone belts. The foliation was likely developed concurrent with folding which is expressed by a west-northwest-trending, isoclinal syncline. Easton (2010) reported the existence of an east-trending shear zone apparently overprinting only the greenstone rocks. Later truncation of the foliation by plutonic material indicates that much of this deformation occurred prior to at least the youngest phase of emplacement of the ca. 2.716 to 2.651 Ga Ramsey-Algoma granitoid complex (Jensen, 1994).

Subsequent to emplacement of the Ramsey-Algoma granitoid complex, D₂ deformation formed a series of northeast-striking sinistral strike-slip faults and shear zones, and later subvertical east-northeast-striking sinistral-oblique faults and shear zones that were formed along the margins of the greenstone belts. At least two regionally extensive east- to northeast-trending faults (the Murray and Flack Lake faults) may have initiated during D₂. The Flack Lake Fault transects the southern portion of the assessment area, while the Murray Fault occurs approximately 60 km south of the assessment area along the north shore of Lake Huron and continues northeast to transect the Sudbury Igneous complex. The Flack Lake Fault has been variously interpreted as a Neoproterozoic thrust fault or listric-normal fault that was inverted during the Neoproterozoic and reactivated during the Blezardian (D₄) and Penokean (D₅) orogenies (Jensen, 1994 and Jackson, 2001); or as a listric normal fault that initiated in relation to rifting of the Archean continental margin during the early Proterozoic (Zolnai et al. 1984; Spray et al., 2004). Jensen (1994) suggests that south of the study area in the Whiskey Lake greenstone belt, two episodes of Archean faulting produced northeast-trending, arcuate sinistral faults and subsequent east-northeast-trending, subvertical sinistral faults.

Table 1.1: Geological and Structural History of the Area (adapted from JDMA, 2014a)

Approximate Time Period (years before present)	Geological Event
2.72 to 2.651 Ga	<p>Kenoran Orogeny</p> <ul style="list-style-type: none"> • Deposition, emplacement and deformation of the ca. 2.72 to 2.68 Ga Whiskey Lake and Benny Lake greenstone belts and ca. 2.716 to 2.651 Ga Ramsey-Algoma granitoid complex. • Development of folds and east-trending foliation in the greenstone belts (ca. 2.72 to 2.70 Ga). [D1]
<2.651 to 2.50 Ga	<ul style="list-style-type: none"> • Early (re)activation of NE-, ENE-, E-W-, WNW- and NW-striking faults (e.g., Murray and Flack Lake faults) [D2]
2.497 to 2.47 Ga	<p>Onset of continental break-up [D3]; rifting across Lake Superior.</p> <ul style="list-style-type: none"> • Deposition of volcanic rocks and basal sedimentary rocks of the Huronian Supergroup. • Reactivation, or continued activity, of WNW- to NW- and E-striking faults. <p>Widespread mafic magmatism, and emplacement of:</p> <ul style="list-style-type: none"> • Agnew Lake intrusion and East Bull Lake intrusion (ca. 2.49 to 2.47 Ga); • Matachewan dyke swarm (ca. 2.473 Ga).
2.47 to > 2.30 Ga	<p>Bleazardian Orogeny [D4]</p> <ul style="list-style-type: none"> • Thick-skinned folding of Archean basement and basal rocks of the Huronian Supergroup. Initiation of Quirke Lake syncline and Chiblow anticline.
<2.3 and > 2.10 Ga	<p>Transition to passive margin setting</p> <ul style="list-style-type: none"> • Continued deposition of sedimentary rocks of Huronian Supergroup. <p>Emplacement of:</p> <ul style="list-style-type: none"> • Biscotasing dyke swarm (ca. 2.167 Ga); • Marathon dyke swarm (ca. 2.121 Ga).
2.10 to 1.89 Ga	Denudation of bedrock and formation of peneplain.
1.89 to 1.84 Ga	<p>Penokean Orogeny [D5]</p> <ul style="list-style-type: none"> • Crustal shortening and development of thrust-and-fold belt in rocks of the Huronian Supergroup, buckling and faulting of Archean basement. • Subgreenschist and amphibolite grade metamorphic overprint to north and south of Murray fault, respectively. <p>Emplacement of:</p> <ul style="list-style-type: none"> • Sudbury Igneous Complex (ca. 1.85 Ga); • North Channel dyke swarm (ca. 1.6 to 2.5 Ga, and associated with ca. 1.884 Ga Molson dyke swarm and Wabigoon dyke swarm).
1.75 to 1.70 Ga	Emplacement of ca. 1.70 Ga Cutler pluton, associated metasomatism of the Huronian Supergroup, and metamorphic overprint of rocks south of Murray fault, ca. 1.75 to 1.70 Ga (Fedó et al., 1997).
1.238 to 1.235 Ga	Emplacement of Sudbury dyke swarm and related intrusions of unclassified olivine diabase dykes.
1.25 to 0.98 Ga	<p>Grenville Orogeny</p> <ul style="list-style-type: none"> • Develop of Midcontinental Rift (ca. 1.1 Ga) [D6]
<1.1 to present	Denudation of bedrock, formation of peneplain, ca. 1.1 to 0.54 Ga. Sedimentation, erosion, transgression and regression of sea water, shallow sea, glaciations. Exhumation of peneplain ca. 0.54 Ga to present.
Ca. 0.59 Ga	Emplacement of Grenville dyke swarm

Jolly (1978) and Zolnai et al. (1984) suggest that subsequent to D_2 , Archean faulting was followed by a large-scale rifting event (D_3) that overprinted the area in association with the ca. 2.497 to 2.47 Ga break-up of the Superior Craton (Williams et al., 1991). This was associated with the development of east-trending rifts and overlapped in time with the earliest Proterozoic deposition of the basal volcano-sedimentary rocks of the Huronian Supergroup (Jensen, 1994); the widespread emplacement of mafic intrusions such as the Agnew Lake and East Bull Lake intrusions (Vogel et al., 1998; Easton, 2009) southeast of the study area; and emplacement of the pervasive Matachewan dyke swarm. D_3 was associated with reactivation of regional D_2 faults, including the Murray and Flack Lake faults, as down-to-the-south synsedimentary growth faults during the formation of the Huronian Supergroup (Zolnai et al., 1984). This event was accompanied by the initiation, or dextral reactivation, of east-southeast- to southeast-striking faults that cross-cut earlier formed structures throughout the Huronian Supergroup (Jackson, 2001). These younger faults also cut the Archean basement and the Murray fault (Jackson, 2001). Jensen (1994) indicates that the southeast-trending faults are intruded by undeformed feldspar porphyry dykes, presumably associated with the Matachewan and Sudbury dyke swarms. While typically assumed to be the youngest generation of faulting, Jensen (1994) and Jackson (2001) concede that some of the southeast-trending faults may have initiated as Late Archean (D_2) structures that subsequently experienced a long history of reactivation during and post-dating the D_5 Penokean Orogeny.

The Blezardian Orogeny is assigned as the fourth deformation event, D_4 , in the area. The Blezardian Orogeny produced steeply south-dipping reverse faults and upright, kilometre-scale folds (Zolnai et al., 1984). The timing of the Blezardian Orogeny is poorly constrained. It is thought to have occurred between ca. 2.4 Ga (possibly as early as 2.47 Ga), and 2.3 Ga (Riller et al., 1999; Raharimahefa et al., 2011).

The ca. 1.89 to 1.84 Ga Penokean Orogeny (D_5) involved dextral shearing and horizontal shortening (Riller et al., 1999) in the area. Crustal shortening and fault reactivation enhanced the previously buckled (Blezardian) structure of the Archean basement and further compressed, folded and faulted rocks of the Huronian Supergroup, so that overlapping thrust blocks stacked up to possibly 15 km in burial thickness (Zolnai et al., 1984). South of the assessment area, and south of the Murray Fault, medium to high grade metamorphic assemblages developed within Huronian Supergroup rocks, and penetrative, ductile deformation features developed that included cleavage, stretching lineation, and rotation of the tectonic fabric to a near-vertical orientation (Zolnai et al., 1984). Ductile deformation features associated with D_5 are not observed in the assessment area. Northwest-trending strike-slip faults such as the Spanish River fault, Pecors Lake and Horne Lake faults that cut the Huronian Supergroup sequence and the parallel Nook Lake fault within the Archean basement directly north of the Quirke Lake syncline (Robertson, 1968), may have been formed during the Penokean Orogeny, or they may be reactivated Archean faults as suggested by Jackson (2001). The effect that the syn-Penokean meteorite impact, which produced the Sudbury Igneous Complex, had on the geological and structural evolution of the area is unclear.

Deformation associated with the Grenville Orogeny (D_6), ca. 1.250 to 0.98 Ga, is considered the final major deformation episode. In spite of the scarcity of evidence and problems of deformation overprinting and fault reactivation, it seems that the Murray fault remained active or was reactivated during this orogeny (Robertson, 1970; Card, 1978; McCrank et al., 1989; Piercey, 2006). The Midcontinent Rift (ca. 1.1 to 1.0 Ga) was developed contemporaneously with the long-lived Grenville Orogeny and is also included as part of D_6 , although its effect on the area is not known. There are poor constraints on any subsequent fault reactivation in the area.

2.3.1 Mapped Structures

In the area, the regional scale arcuate east-trending Flack Lake fault extends for approximately 150 km and transects the Ramsey-Algoma granitoid complex in the southern portion of the study area. The Flack Lake fault is interpreted as a north-directed listric thrust that reactivated an earlier normal fault. Its movement history may be related to the Penokean event (Bennett et al., 1991).

2.4 Metamorphism

Studies on metamorphism in Precambrian rocks across the Canadian Shield have been summarized in a few publications since the 1970s (e.g., Fraser and Heywood, 1978; Kraus and Menard, 1997; Menard and Gordon, 1997; Berman et al., 2000; Easton, 2000a; 2000b; Holm et al., 2001, and Berman et al., 2005) and the thermochronological record for large parts of the Canadian Shield is documented in a number of studies (Berman et al., 2005; Bleeker and Hall, 2007; Corrigan et al., 2007; and Pease et al., 2008).

The Superior Province of the Canadian Shield largely preserves low-pressure–high-temperature Neoproterozoic (ca. 2.710–2.640 Ga) metamorphic rocks. The relative timing and grade of regional metamorphism in the Superior Province corresponds to the lithological composition of the subprovinces (Easton, 2000a; Percival et al., 2006). Subprovinces comprising volcano-sedimentary assemblages and synvolcanic to syntectonic plutons (i.e., granite-greenstone terranes) are affected by lower greenschist to amphibolite facies metamorphism. Subprovinces comprising both metasedimentary- and migmatite-dominated lithologies, such as English River and Quetico, and dominantly plutonic and orthogneissic domains, such as Winnipeg River, are affected by middle amphibolite to granulite facies metamorphism (Breaks and Bond, 1993; Corfu et al., 1995). Subgreenschist facies metamorphism in the Superior Province is restricted to limited areas, notably within the central Abitibi greenstone belt (e.g., Jolly, 1978; Powell et al., 1993).

In general, most of the Canadian Shield preserves a complex episodic history of Neoproterozoic metamorphism overprinted by Paleoproterozoic tectonothermal events culminating at the end of the Grenville orogeny ca. 950 Ma. The distribution of contrasting metamorphic domains in the Canadian Shield is a consequence of relative uplift, block rotation, and erosion resulting from Neoproterozoic orogenesis, subsequent local Proterozoic orogenic events and broader epeirogeny during later Proterozoic and Phanerozoic eons.

Metamorphic grade in the area is largely of subgreenschist facies north of the Murray Fault, east and north of Blind River. South of the Murray Fault (Piercey, 2006), metamorphism increases to localized lower amphibolite facies extending eastward between Blind River, Sudbury and the Grenville Front (Riller et al., 1999). Most authors (e.g., Zolnai et al., 1984) have considered the medium grade metamorphism reached south of the Murray fault to be a product of tectonothermal burial. However, Jackson (2001) pointed out that the high temperature-low pressure metamorphism reached could not be solely the result of burial, and he advanced the alternative of a second period of crustal extension in the area. This hypothesis would not only account for the required heat for medium grade metamorphism but would also explain the emplacement of Nipissing intrusions south of the area. Holm et al. (2001) suggested that peak Penokean Orogeny metamorphism occurred ca. 1.835 Ga, based on monazite ages. More recently, Piercey (2006) showed that the Penokean Orogeny was only the first of several accretionary events that impinged on the southern Laurentide margin and presented evidence of a younger and more significant metamorphic event, possibly related to the Yavapai tectonothermal pulse at ca. 1.7 Ga. This event may have affected the metamorphic conditions

in the area and possibly increased the metamorphic overprint to greenschist facies, at least in the area proximal to the Cutler pluton on the north side of the Murray fault. Fedo et al. (1997) indicated that a ca. 1.7 to 1.75 Ga metasomatic event is evident in potassic and sodic alterations of the Huronian Supergroup north of the Murray Fault. This event likely replaces most metamorphic minerals in the Huronian Supergroup with white mica and is presumably related to fluid-flow driven by post-orogenic uplift of the Penokean Orogeny. Minor contact metamorphism exists in the metavolcanic rocks of the greenstone belt near some of the large Proterozoic mafic intrusions (Rogers, 1992).

2.5 Quaternary Geology

Quaternary geology of the area is described in detail in the terrain evaluation completed as part of the Phase 1 Desktop Preliminary Assessment (JDMA, 2014b). An overview of the relevant Quaternary features are summarized below.

The Quaternary geology of the area is dominated at surface by different types of glacial deposits that accumulated with the progressive retreat of the ice sheet during the end of the Wisconsinan glaciation. This period of glaciation began approximately 115,000 years ago and peaked approximately 21,000 years ago, at which time the glacial ice front extended south of Ontario into what is now Ohio and Indiana (Barnett, 1992).

The area is dominated by exposed bedrock or bedrock having only a thin cover of unconsolidated sediments. Quaternary deposits are predominantly located in bedrock controlled valleys. Overburden deposits within this area were mapped as part of the Northern Ontario Engineering Terrain Study (NOEGTS), a program undertaken between 1977 and 1981 (Gartner, 1978a,b,c; 1980 a,b; Roed and Hallet, 1979a,b,c,d; 1980a,b; VanDine, 1979a,b,c,d; 1980a,b,c,d; Gartner et al., 1981). These studies divided the landscape into a set of distinct terrain units within which the engineering characteristics are broadly predictable.

Data on ice flow direction compiled from the literature (Karrow, 1987) reveal that glacial ice flowed in a generally southwesterly direction across the area from the Hudson Bay basin. Ford (1993) recognized two dominant orientations in glacial striations, lunate fractures, drumlinoid features, and till flutings in the Rawhide Lake area to the north of the City of Elliot Lake. These are recorded as 175° (165° to 180°) and 195° (190° to 210°). At three sites, older 100° to 120° striations were found intersecting either the 175° or 195° sets.

The most widely occurring and oldest known stratigraphic unit in the area is a silty sand to sandy silt till found overlying bedrock in low relief areas and along the flanks of topographic lows. It is typically thin and discontinuous and is coarse-textured, unsorted, and boulder-rich, although there are some areas of compact, massive to fissile and gravelly to silty and sandy till (Barnett et al., 1991). Glaciolacustrine sediments have more limited distribution and are limited to only very small mappable surficial units (Ford, 1993) largely along river valleys. These units are typically composed of laminated silt and fine sand and silt-clay rhythmites, and may be related to the series of postglacial lakes of the Lake Huron basin.

Deposits of glaciofluvial outwash are commonly encountered along valleys in the area. Glaciofluvial outwash is common in low-lying areas and occasionally in esker ridges with the local formation of terraces related to changing lake levels in the Lake Huron basin. Thick deposits of alluvial sand and gravel are found along many of the rivers in the region. Recent swamp, lake, and stream deposits are also common throughout the area (JDMA, 2014b). A more detailed accounting of glacial deposits in the area is provided by JDMA (2014b).

3 Data Source Acquisition and Quality

Sander Geophysics Limited (SGL) completed a fixed-wing high-resolution airborne magnetic and gravity survey in the Elliot Lake and Blind River area from April 2016 to May 2016 and from February 2017 to March 2017. The survey area comprised one survey block located northeast of the city of Elliot Lake. The survey block was designed to cover the potentially suitable area in the Ramsey-Algoma granitoid complex identified in the Phase 1 preliminary assessment and capture relevant geological features. The survey included a total of 10,057 km of flight lines covering a surface area of approximately 1,600 km².

Flight operations were conducted out of Elliot Lake Municipal Airport, Ontario using two Britten Norman Islanders. Data were acquired along traverse lines flown in a north-south direction spaced at 100 m, and control lines flown east-west spaced at 500 m. Five survey lines spaced 200 m apart were continued from the Elliot Lake and Blind River block 40 km south, transecting the East Bull Lake intrusion to the south. The same five survey lines, spaced 200 m apart, were also continued north 15 km beyond the edge of the survey area (Figure 1.2). The lines, referred to as regional trend lines, provide a regional context to the interpretation. The survey was flown at a nominal altitude of 70 m above ground level, with an average ground speed of 95 knots (approximately 176 km/h or 49 m/s). Airborne magnetic and gravity data were acquired using equipment with very high sensitivity and accuracy. The airborne magnetic data was recorded using a magnetometer sensor mounted in a fibreglass stinger extending from the tail of the aircraft. The airborne gravity data was recorded using a gravimeter, which includes three orthogonal accelerometers that are mounted on a stabilized platform inside the cabin of the aircraft. Table 3.1 gives a quick reference of the details of the survey.

Table 3.1: Survey Details

Survey Particulars	
Survey Start Date:	April 27, 2016
Survey End Date:	March 2, 2017
Field Office Location:	Elliot Lake
Airport Used:	Elliot Lake Municipal Airport (CYEL)
Aircraft Type:	Britten Norman Islanders (registration C-GSGR and C-GSGX)
Total line kilometers:	10,057
Traverse Line numbers:	1001-1331
Traverse Line direction:	North-South
Traverse Line spacing:	100 m
Control Line numbers:	101-160 (excl. 120-122), 200-204
Control Line direction:	East – West
Control Line spacing:	500 m
Survey Altitude:	Smoothed drape with target height of 70 m above ground
Digital Terrain Source:	SRTM
Number of Flights (numbers):	1001-1019
Aircraft Target Ground Speed:	95 knots
Magnetic Field Reference location	(NAD83 UTM 17N): 411,575.2m E 5,194,003.57m N
Magnetic Field Inclination (+ve down):	72.436°
Magnetic Field Declination (+ve east):	-9.383°
Approximate total field value:	55469.4 nT
Magnetic Reference Field Model:	International Magnetic Reference Field (IGRF-12), interpolated to date and location of acquisition
Fundamental Gravity Network Ties:	Referenced to the local gravity value established by Sander Geophysics at the Ottawa Airport
Survey Base Gravity Value:	980644.00 mGal
Survey Base Parking Location (NAD83 UTM 17N):	380,239.5m E 5,134,255.7m N Height: 289.27 m (above WGS-84 ellipsoid)
Base Station Locations (NAD83 UTM 17N):	REF1: 372,942.4m E 5,138,147.7m N Height: 301.363 m (above WGS-84 ellipsoid) REF2: 372,940.8m E 5,138,147.3m N Height: 301.236 m (above WGS-84 ellipsoid) REF6: 372,945.2m E 5,138,150.0m N Height: 301.211 m (above WGS-84 ellipsoid) REF9: 372,948.1m E 5,138,153.6m N Height: 301.126 m (above WGS-84 ellipsoid)
Field Acquisition Datum:	WGS-84
UTM Projection:	UTM 17N

3.1 Magnetic Data

Total magnetic field measurements were recorded with a single cesium magnetometer mounted in a fiberglass stinger extending from the tail of the survey aircraft. SGL's hardware and software system, AIRComp, was used to remove the effects of the aircraft and its manoeuvres from the recorded magnetic data. Coefficients to be used for compensation were derived by processing the calibration flight data, based on principles presented by Leliak (1961). The compensation coefficients were applied to data recorded during normal survey operations to produce compensated magnetic data.

Low-pass filtered reference station diurnal was subtracted from the airborne data on a reading by reading basis.

Both the ground and airborne systems used the Geometrics G-822A cesium magnetic sensor. Total magnetic field measurements were recorded at 160 Hz in the aircraft, and then later down sampled to 10 Hz in the processing. A second order Butterworth 0.9 Hz low-pass filter is utilised in the process for compensation and anti-aliasing. The ground systems recorded magnetic data at 11 Hz.

A pre-planned drape surface was prepared for the survey to guide the aircraft over the topography in a consistent manner, as close to the minimum clearance as possible. The drape surface was prepared with digital elevation model (DEM) data obtained from the Shuttle Radar Topography Mission (SRTM) for the area. The DEM included an extension beyond the survey boundary to allow the aircraft to achieve the drape clearance before getting to the beginning of the survey line.

Details of the processing of the magnetic data are provided in Section 4.2 of this report.

3.2 Gravity Data

Gravity data were acquired with SGL's propriety AIRGrav (*Airborne Inertially Referenced Gravimeter*) system, which uses a Schuler tuned inertial platform supporting three orthogonal accelerometers, which remain fixed in inertial space, independent of the manoeuvres of the aircraft, allowing precise isolation from the effects of the movement of the aircraft. The gravity sensor used in AIRGrav is a very accurate accelerometer with a wide dynamic range. The system, after correcting for strong vertical motions of the aircraft, allows the final gravity data to be almost completely unaffected by in-flight conditions classified as "moderate turbulence" or better. The instrument is also considered to be an inertial navigator and as such, the platform levelling was essentially unaffected by horizontal accelerations.

In typical survey flying, accelerations in an aircraft can reach 0.1 G, equivalent to 100,000 milligal. Data processing must extract gravity data from this very noisy environment. This was achieved by modelling the gravity due to movements of the aircraft in flight as measured by extremely accurate Global Positioning System (GPS) measurement. These measurements are affected by noisy conditions in the ionosphere, and by the variable conditions (e.g. temperature, pressure and humidity) within the troposphere. SGL has developed a full suite of programs to carry out all the necessary corrections.

The GPS data are extracted from the airborne and reference station acquisition system and reformatted. Differential corrections to correct the airborne ranges for variations calculated from the base station GPS data were performed. Each recorded position was recalculated based on these ranges. The original reference system for all GPS data was the WGS-84 datum. Positions were then converted to the local datum, reference system and desired projection. Each line was then checked for data continuity and quality.

An extremely accurate location of the base station GPS receiver is determined using an IGS permanent GPS Reference Station to apply differential corrections (<http://igs.org/network>). This technique provides a final base station receiver location with an accuracy of better than a few decimetres. The entire airborne data set is then reprocessed differentially using the recalculated base station location.

Gravity data were recorded at 128 Hz. Accelerations were filtered and resampled to 10 Hz to match the GPS, using specially designed filters to avoid biasing the data. Gravity was calculated by subtracting the GPS derived accelerations from the inertial accelerations. The calculated gravity was corrected for the Eötvös effect and latitude corrected (i.e. normal gravity), and the sample interval was then reduced to 2 Hz. These operations were all performed by SGL's proprietary GravGPS software. A detailed description of gravity processing is provided in Section 4.1 of this report.

3.3 Digital Elevation Data

Digital elevation data were collected during the survey using a laser altimeter (Riegl LD90-31K-HiP) mounted to the base of the aircraft. The elevation data were sampled at a rate of 3.3 Hz, which is consistent with a sample roughly every 16 m along the profile line. Even though the laser altimeter can record returns from more than 700 m above the ground with a high degree of certainty, some laser data dropouts occurred while flying over the areas of poor reflectivity. The laser data shows the effects of the dense tree cover; variable penetration of the canopy, with first pulses representing tree tops and last pulses representing ground level or lower levels vegetation. This results in a high-frequency variation of recorded altitude. The raw laser data were processed with an iterative de-spiking routine designed to remove many of the early laser returns from trees.

Digital elevation data were also collected using a King radar altimeter mounted to the base of the aircraft. The radar altimeters have a larger footprint than laser altimeters and give readings that vary less rapidly along the survey line and will partially penetrate the canopy to a depth dependent on the tree density. Elevation data were sampled at a rate of 10 Hz, which is consistent with a sample roughly every 6 m and were filtered to remove high-frequency noise using a low-pass filter with a cut off between 3.3 seconds (99% pass) and 1.5 seconds (1% pass).

A digital elevation model (DEM) was derived by subtracting the laser altimeter data from the differentially corrected DGPS altitude with respect to the Canadian Geodetic Vertical Datum 2013 (CGVD2013). Short sections of poor laser data due to locally weak reflectivity were replaced using King radar data. The DEM reflects the presence of vegetation (for example trees) and buildings and thus is not considered to be a digital terrain model (DTM).

The digital elevation data were gridded to form a DEM grid using a cell size of 25 m over the Elliot Lake and Blind River survey area. The 25 m grid cell size was used to present the highest resolution of the digital elevation model within the boundaries of the survey block comprising the principal survey area (Figure 3.1).

3.4 Additional Data Sources

In addition to the acquired data, a number of other publicly available data sources were used. These are detailed below.

3.4.1 OGS Mapped Bedrock Geology

The Precambrian Geoscience Section of the Ontario Geology Survey has compiled a 1:250,000 scale

map of the bedrock geology of Ontario (OGS, 2011). These maps were recently revised and issued as 'Miscellaneous Release – Data 126 – Revision 1'. The data is publicly available as a seamless GIS data set and includes such details as bedrock units, major faults, dyke swarms, iron formations and kimberlites. This resource was of fundamental importance in assisting with the geophysical interpretation of the acquired potential field data. The mapped bedrock geology was used for both qualitative and quantitative aspects of the interpretation. In the case of the qualitative interpretation, the mapped bedrock geology gave the overall context for the magnetic and gravity data. For the 2.5D modelling, the mapped bedrock geology provided surface constraints.

3.4.2 Geological Base Maps

An additional geological map (Map 2670) is available at 1:250,000 scale of the bedrock geology covering part of a group of traverse lines that were extended past the southern boundary of the main area of the survey block to capture the regional features (Johns et al., 2003).

3.4.3 OGS PETROCH Lithogeochemical Database

The Ontario Geological Survey has a publicly available PETROCH Lithogeochemical Database (Haus and Pauk, 2010). The database contains detailed rock chemical data collected by OGS geoscientists, which includes information about rock type, chemical composition, age, stratigraphy, major oxide values, sample location and specific gravity. Densities from eighteen data points of syenite samples of the Parisien Lake Syenite and 59 data points of gabbro samples of the East Bull Lake intrusion were used in the interpretation.

3.4.4 Densities and Magnetic Susceptibilities

Bedrock densities and magnetic susceptibilities in the Elliot Lake and Blind River area were gathered from a database maintained by the Geological Survey of Canada (GSC, 2015). The database includes classification of rock type, and measured densities and magnetic susceptibilities. No magnetic susceptibility values are available in the database for any on the geological units along the modelled profiles. Densities from forty six data points of granite samples, three of gneiss samples, six of mafic volcanic samples, and thirty three gabbro samples from the area were used in the interpretation.

3.4.5 Geological, Geochemical and Geophysical Data from the Elliot Lake Area, Southern and Superior Provinces, Ontario

The Ontario Geological Survey has publicly available Geological, Geochemical and Geophysical Data base from the Elliot Lake Area, Southern and Superior Provinces, Ontario (Easton, 2013), which is known as Miscellaneous Release – Data 305. The release contains field photographs, whole-rock chemistry, isotope geochemistry, assay, geochronology, magnetic susceptibility and scintillometer data. The database area is south of the main surveyed area covering part of a group of traverse lines that were extended past the southern boundary of the main area of the survey block to capture the regional features. Magnetic susceptibility values for, syenite, gabbro, granite, granodiorite and mafic volcanic rock samples in the area were used in the interpretation. This was the only source of local magnetic susceptibility measurements.

4 Geophysical Data Processing Methods

4.1 Gravity Data Processing

Advanced gravity processing allows for the generation of high-resolution gravity data. These processes involve the use of GPS phase angle corrections, the integration of GPS processing with inertial data from the gravimeter and the advanced analysis of system states and uncertainties. This processing helps reduce system noise and allows for the generation of high quality, low noise raw gravity data through a wider range of survey conditions than was previously possible. The following standard corrections were applied to the gravity data (Telford et al., 1990; Blakely, 1996):

- a. Eötvös correction,

$$\delta g_{Eötvös} = - \frac{v_x^2}{\frac{r}{(1 - e^2 \sin^2 \Phi)^{1/2}} + h} - 2 W_s v_x \cos \Phi - \frac{v_y^2}{\frac{r(1 - e^2)}{(1 - e^2 \sin^2 \Phi)^{3/2}} + h}$$

where Φ is the latitude of the aircraft, v_x and v_y are the velocities of the aircraft in the x (east) and y (north) direction, r is the Earth's radius at the equator (6,378,137 m), e is a correction for Earth's flattening towards the poles (0.0818191908426), W_s is the angular velocity of Earth's rotation ($7.2921158553 \times 10^{-5}$ rad/s), and h is the altitude of the plane above the ellipsoid;

- b. Normal gravity,

$$g_{Normal} = \frac{9.7803267715(1 + 0.0019318513353 \sin^2 \Phi)}{\sqrt{1 - 0.0066943800229 \sin^2 \Phi}}$$

where Φ is the latitude of the aircraft;

- c. Free air correction,

$$g_{fa} = -(0.3087691 - 0.0004398 \sin^2 \Phi)h + 7.2125 \times 10^{-8} h^2$$

where h is the height of the aircraft in metres above the ellipsoid;

- d. Full 3D Bouguer correction, g_b . See below for a description of the Bouguer correction technique;
 e. Static correction, g_{sc} , based on static ground recordings and repeat lines;
 f. Level correction, g_{lc} , based on line intersections.

Thus, the Bouguer anomaly in mGal is determined:

$$\text{Bouguer Anomaly} = G - g_{fa} - g_b - g_{sc} - g_{lc}$$

where G is the calculated gravity in mGal adjusted for Eötvös effect and normal gravity.

4.1.1 Bouguer Correction

Shuttle Radar Topography Mission (SRTM) digital elevation model data were used to calculate the Bouguer corrections for gravity processing. The SRTM data used contains information in a grid with a 3 arcsecond spacing, approximately equal to 100 m cell size. Coverage up to 160 km from the survey

block was kept for accurate regional corrections.

Terrain corrections were computed using software developed by SGL. The algorithm calculates the topographic attraction of the terrain using a mass prism model with a constant density. The difference between the topographic attraction and the simple Bouguer correction is the terrain correction. The terrain and Bouguer corrections were calculated for the bedrock at the height of the aircraft using a density of 2.67 g/cm^3 .

Terrain corrections were filtered to match the degree of filtering applied to the gravity data as described below.

4.1.2 Static and Level Corrections

The gravimetric data were levelled to compensate for instrument variations in two steps. A single constant shift determined from ground static recordings was applied on a flight-by-flight basis. The pre- and post-flight readings were averaged for each flight and the difference between the average value and the local gravity value was removed. This acts as a simple but effective coarse levelling of the data.

Intersection statistics were then used to adjust individual survey lines. Unlike magnetic levelling, individual intersections were not used to make corrections. Instead, intersection differences from whole lines were averaged and a single adjustment was applied to each survey line and each control line. Minor adjustments were calculated for sections of each line based on statistics from groups of intersections. The adjustments were smoothed and applied to line data that was filtered as described below. Grids of adjusted data were inspected to determine that the adjustments were appropriate.

4.1.3 Gridding and Filtering

Statistical noise in the data was reduced by applying a cosine tapered low-pass filter to the time series line data. For this survey, a 20 second (1000 m) half-wavelength filter was employed. The data were gridded using a minimum curvature algorithm that averages all values within any given grid cell and interpolates the data between survey lines to produce a smooth grid. The algorithm produces a smooth grid by iteratively solving a set of difference equations by minimizing the total second horizontal derivative while attempting to honour the input data (Briggs, 1974). Grids were generated using a 25 m grid cell size.

Low-pass spatial filtering is applied to the grid for noise reduction. Essentially, the survey area is over-sampled as the line spacing is smaller than the grid filter used. A range of grid filters were used and evaluated for noise levels and signal content. Final data for this survey was filtered with a 1.0 km half-wavelength grid filter.

The gravity data were gridded using a cell size of 25 m and 250 m over the survey area. The 25 m gridding cell was applied to present the highest resolution of data within the boundary of the survey block, comprising the principal survey area. The 250 m gridding cell was applied to include the extensions of the flight lines beyond the survey block, comprising the extended survey area. The Bouguer gravity with a terrain correction of 2.67 g/cm^3 is displayed in Figures 4.1 (principal survey area, grid cell size of 25 m) and Figure 4.2 (extended survey area, grid cell size of 250 m). The Free Air gravity is displayed in Figures 4.3 (principal survey area, grid cell size of 25 m) and Figure 4.4 (extended survey area, grid cell size of 250 m).

4.2 Magnetic Data Processing

The airborne magnetometer data were recorded at 160 Hz, and down sampled to 10 Hz for processing. A second order Butterworth 0.9 Hz low-pass filter is utilized in the process for compensation and anti-aliasing. All magnetic data were plotted and checked for any spikes or noise. A 0.244 second static lag correction due to signal processing, plus a dynamic lag correction which varies between 0.04 s and 0.06 s, depending on the instantaneous velocity of the aircraft, was determined on a line-by-line basis using SGL's Dynlag software.

Ground magnetometer data were inspected for cultural interference and edited where necessary. All reference station magnetometer data were filtered using a low-pass filter with a cut off between 3.0 seconds (99% pass) and 1.7 seconds (1% pass) to remove any high-frequency noise, but retain the low-frequency diurnal variations.

A correction for the International Geomagnetic Reference Field (IGRF) year 2015 model was applied to all ground magnetometer data using the fixed ground station location and the recorded date for each flight. Three ground stations were employed to correct for diurnal variations. GDN1 was used for all flights performed in 2016 (flights 1001 to 1009). GDN2 was used for flights 1012 and 1014 to 1018 in 2017. GDN3 was used for flights 1010, 1011, 1013, 1018 and 1019. The mean residual values of each reference station were calculated and subtracted to remove any bias when correcting the local anomalous field on the survey grid as follows: GND1 558.412 nT, GND2 229.826 nT, GND3 767.999 nT. A further adjustment of 0.615 nT was applied to GND3 to account for a residual offset. Diurnal variations in the airborne magnetometer data were removed by subtracting the reference station data after subtraction of the mean residual.

The airborne magnetometer data were also corrected for the IGRF using the location, altitude, and date of each point. IGRF values were calculated using the year 2015 IGRF model. The altitude data used for the IGRF corrections are DGPS heights above the WGS84 datum.

4.2.1 Levelling

Intersections between control and traverse lines were determined by a program which extracts the magnetic, altitude, and x and y values of the traverse and control lines at each intersection point. Each control line was adjusted by a constant value to minimize the intersection differences, calculated as follows:

$\sum |i - a|$ summed over all traverse lines, where:

i = (individual intersection difference)

a = (average intersection difference for that traverse line).

Adjusted control lines were further corrected locally to minimize any residual differences. Traverse line levelling was carried out by a program called CLEVEL that interpolates and extrapolates levelling values for each point based on the two closest differences at intersections. After traverse lines were levelled, the control lines are matched to them. This ensured that all intersections tie very closely and permitted the use of all data in the final products.

CLEVEL provides a curved correction using a function similar to spline interpolation. A third degree polynomial was used to interpolate between two intersections. CLEVEL allows intersection points to be preserved with no mismatch and interpolation is smooth with the first derivative continuously

approaching the same value from both sides of the intersection points.

The levelling procedure was verified through inspection of the magnetic anomaly and vertical derivative grids, by plotting profiles of corrections along lines, and by examination of levelling statistics to check for steep correction gradients.

4.2.2 Gridding

The grid of the total magnetic intensity was made using a minimum curvature algorithm to create a two-dimensional grid equally sampled in the x and y directions following Briggs (1974). The final grids of the magnetic data were created with a 25 m grid cell size, appropriate for survey lines spaced at 100 m. A magnetic grid was made of a larger area using only the 1000 m spaced lines that extended beyond the main block area (plus appropriate control lines). These were gridded with a cell size of 250 m. The 25 m gridding cell was applied to present the highest resolution of data within the boundary of the survey block, comprising the principal survey area and the regional trend lines. The 250 m gridding cell was applied to include the extensions of the flight lines beyond the survey block, comprising the extended survey area. The total magnetic intensity (or more correctly, the magnetic anomaly) is displayed in Figures 4.5 (principal survey area, grid cell size of 25 m) and Figure 4.6 (extended survey area, grid cell size of 250 m).

4.2.3 Micro-Levelling

Micro-levelling is a grid based processing procedure occasionally applied to magnetic data to remove any residual diurnal effects by using directional filters to identify and remove artifacts that are long wavelengths parallel to survey lines and short wavelengths perpendicular to survey lines. When microlevelling was applied, the changes at any location were restricted to 0.2 nT or less.

4.3 Gravity and Magnetic Derivative Products

Filters may be applied to the data to enhance different wavelength information that arises from different sources. In many cases, filtering is best achieved by transforming the data from the space domain to the frequency domain by Fourier transform since the frequency characteristics of the filter to be applied are more precisely defined in the frequency domain. The filtered derivatives created to assist with interpretation are described below.

4.3.1 Total Magnetic Intensity Reduced to Pole

Reduction to the pole (RTP) transforms anomalies into what they would be if the inclination of the magnetic field were 90 degrees. The basic assumption is that magnetic anomalies arise from induced magnetization. This assumption may not always be true where significant magnetic remanence occurs. The method allows direct comparison of anomaly shapes from different magnetic latitudes, and if the assumptions hold true, the anomaly will be symmetrically disposed about the causative body. Reduction to pole is essentially a phase shift filter applied in the frequency domain, and is described by Baranov and Naudy (1964):

$$F(k_x, k_y) = \frac{1}{[\sin I + i \cos I \cos(D - \theta)]^2},$$

where

- k_x and k_y are the wave numbers of the potential field in the two-dimensional frequency domain,
- θ is the angle in the k_x k_y plane,
- I is the local magnetic inclination,
- D is the local magnetic declination.

For ease of calculation, this transformation was performed through filtering in the frequency domain using a constant (average/central) inclination and declination which was considered valid throughout the entire grid. The inclination used was 72.288° , and the corresponding declination used was -10.331° representing a station approximately at the centre of the survey. The total magnetic intensity reduced to the pole is shown in Figure 4.7 (principal survey area, grid cell size of 25 m) and Figure 4.8 (extended survey area, grid cell size of 250 m).

4.3.2 Vertical Derivatives of Total Magnetic Intensity and Bouguer Gravity

The n^{th} vertical derivative of a potential field is easily derived in the Fourier domain by applying the following filter:

$$F(k_x, k_y) = (-k)^n \quad \text{where } k = \sqrt{(k_x^2 + k_y^2)}.$$

Vertical derivatives act as high-pass filters that enhance high-frequency data and suppress low-frequency data. The first vertical derivative ($n=1$) enhances the rapid changes in gravity or magnetic field at the edges of anomalies and is therefore useful for delimiting the extents of causative bodies. The second vertical derivative ($n=2$) enhances high-frequency signal variations even more, such that textural variations in the character or the potential field (especially for magnetic data) can be used to delimit domains of a specific geophysical response.

The first vertical derivative of the reduced to pole total magnetic intensity is shown in Figure 4.9 (principal survey area, grid cell size of 25 m) and Figure 4.10 (extended survey area, grid cell size of 250 m). The first vertical derivative of the Bouguer gravity with a terrain correction using a density of 2.67 g/cm^3 is shown in Figure 4.11 (principal survey area, grid cell size of 25 m) and Figure 4.12 (extended survey area, grid cell size of 250 m). The first vertical derivative of the free air gravity is shown in Figure 4.13 (principal survey area, grid cell size of 25 m) and Figure 4.14 (extended survey area, grid cell size of 250 m). The second vertical derivative of the pole reduced total magnetic intensity is shown in Figure 4.15 (principal survey area, grid cell size of 25 m) and Figure 4.16 (extended survey area, grid cell size of 250 m). The gravity data do not contain high-frequency information to render its second vertical derivative useful for interpretation.

4.3.3 Total Horizontal Gradient of Total Magnetic Intensity and Bouguer Gravity

Horizontal gradients are most conveniently calculated in the space domain, using central differences. Total horizontal gradient of a potential field (T) is from the gradients in the horizontal x and y planes as follows (Nabighian, 1972):

$$\text{Total horizontal derivative} = \sqrt{(\partial T / \partial x)^2 + (\partial T / \partial y)^2}.$$

Horizontal gradient grids are used primarily for edge detection of causative bodies (contacts, faults with large vertical displacement), and the data may also be employed for trend analysis and depth to source calculations.

Total horizontal derivatives of the pole reduced total magnetic intensity, Bouguer gravity (2.67g/cm³ terrain corrections) and free air gravity are shown in Figures 4.17, 4.19, 4.21 (principal survey area, grid cell size of 25 m) and Figures 4.18, 4.20, 4.22 (extended survey area, grid cell size of 250 m).

4.3.4 Total Gradient Amplitude of Total Magnetic Intensity

The total gradient amplitude, otherwise known as the 3D analytic signal amplitude, of a potential field (T) is defined as:

$$|A(x, y)| = \sqrt{(\partial T / \partial x)^2 + (\partial T / \partial y)^2 + (\partial T / \partial z)^2}.$$

$|A(x, y)|$ is the amplitude of the analytic signal and T is the intensity at a point (x, y) . The horizontal derivatives are easily calculated in the space domain, whilst the vertical derivative is calculated in the frequency domain. The analytic signal is mostly independent of field direction and direction of magnetization, and is independent of the type of magnetization (induced or remanent). This means that all similar bodies have a similar analytic signal response, and that peaks in the analytic signal are symmetric and centred over the middle of narrow bodies and the edges of wide bodies. The amplitude however is affected by the strike of a body such that north-south oriented bodies at low latitudes are relatively weak for magnetic data. The analytic signal highlights areas where the field varies quickly in any direction, such as for contacts. The total gradient amplitude of the total magnetic intensity is shown in Figure 4.23 principal survey area, grid cell size of 25 m) and Figure 4.24 (extended survey area, grid cell size of 250 m).

4.3.5 Tilt Angle

The tilt angle can be applied to the pole reduced total magnetic intensity to preferentially enhance the weaker magnetic signals. This is particularly useful for mapping texture, structure, and edge contacts of weakly magnetic sources. The arctan operator restricts the tilt angle to within the range of -90° to +90°, irrespective of the amplitude and wavelength of the field and enhances weak anomalies compared to the stronger anomalies. The tilt angle (Miller and Singh, 1994; Verduzco et al., 2004; Salem et al., 2007) is defined as:

$$\theta = \tan^{-1} \frac{\text{vertical component of gradient}}{\text{horizontal component of gradient}} = \tan^{-1} \left[\frac{\frac{\partial T}{\partial z}}{\frac{\partial T}{\partial h}} \right].$$

The vertical and horizontal gradients of the reduced to pole total magnetic intensity calculations are described above in subsections 4.3.2 and 4.3.3. The tilt angle grid for the reduced to pole total magnetic intensity is displayed in Figure 4.25 (principal survey area, grid cell size of 25 m) and Figure 4.26 (extended survey area, grid cell size of 250 m).

4.3.6 Trend Analysis Method

Depth trend as implemented by Phillips (1997) can be utilized for the depth estimation using the horizontal gradient grid (HG). It uses the horizontal gradient of the reduced to pole total magnetic intensity and gravity grids to estimate strikes of and depths to thick and thin edges, respectively (Phillips, 2000). The method relies on the general principle that shallow sources produce anomalies with steep gradients, whereas deep sources produce anomalies with broad gradients. Depth estimates from the RTP magnetic and gravity data estimate the minimum and maximum depths to the top edge of the layer, respectively (Phillips, 2000).

The program uses a 5 by 5 window to both locate the crests of maxima and determine their strike

direction. Once a crest is located and the strike direction is known, data within the window and within a belt perpendicular to the strike can be used to determine the depth of the contact by performing a least squares fit to the theoretical shape of the HG over a contact. If " h " is the horizontal distance to the contact, " d " is the depth to the top of the contact and " K " is a constant, then the theoretical curve is given by (Roest and Pilkington, 1993):

$$HG(h) = K/(h^2 + d^2).$$

The least-squares fit gives an estimate of both the depth and its standard error, which can be expressed as a percentage of the depth. Typically only depth estimates with standard errors of 15% or better are retained in the final interpretation.

Due to the assumption of thick sources, the depth estimates obtained using the above procedure represent minimum depths. It is also possible to assume very thin sources and use a standard "pseudogravity" transformation instead of reduction to the pole (Roest and Pilkington, 1993). In this case the same analysis is done on the HG of the pseudogravity field, and the depth estimates represent maximum depths only accurate for thin horizontal sheet sources. Figures 4.27 and 4.28 show the depth results from the trend analysis solutions for the Bouguer gravity and the reduced to pole total magnetic intensity using the thick dyke approach.

5 Geophysical Interpretation

The geophysical interpretation of the acquired gravity and magnetic data in the Elliot Lake and Blind River area involved qualitative analysis of the various products derived from the magnetic and gravity grids (described in Section 4), and 2.5D forward modelling of the gravitational and magnetic data along two profile lines covering parts of the Ramsey-Algoma granitoid complex and intrusions and greenstone belts within the study area.

5.1 Results of Qualitative Analysis

Qualitative analysis of the gravity derivative products was used to provide general indications about: the local geometry of the Ramsey-Algoma granitoid complex; location and dip of edges between its granite-granodiorite intrusions and the gneissic tonalite rocks of the complex; variation in depth across the granite-granodiorite suite; and density variations within the rock units. Qualitative analysis of the magnetic derivative products was used to: locate the edges and indicate the dip direction of edges, identify the presence of potential features within the granite-granodiorite suite such as faults and dykes (SRK, 2017); and evaluate variation in the magnetic character that may indicate changing composition of the rocks or other potential heterogeneities.

For the qualitative geophysical interpretation, the Bouguer gravity (Figure 5.1), its first vertical derivative (Figure 5.2) and its total horizontal derivative (Figure 5.3), as well as the reduced to the pole total magnetic intensity (RTP) (Figure 5.4), its first vertical derivative (Figure 5.5), and its total horizontal derivative (Figure 5.6), were primarily utilized. In addition, the total gradient amplitude is useful for interpretation of the magnetic data (Figure 4.23 and 4.24) because: (a) it has a maxima over vertical magnetic contacts regardless of the direction of magnetization; and (b) the magnetic intensity reduced to pole requires the assumption of only induced magnetization with the result that anomalies from remanently and anisotropically magnetized bodies can be severely distorted. Unlike the RTP, the total gradient amplitude will produce maxima over the edges of vertical magnetic contacts regardless of the presence of remanent magnetism (MacLeod, 1993).

The following subsections describe the qualitative observations made about the portion of the Ramsey-Algoma granitoid complex within the survey area.

- Generally the Bouguer gravity drops smoothly from a high over the mapped gneissic tonalite suite (OGS, 2011) at the northern end of the survey area to a gravity low at the southern end within the mapped granite-granodiorite suite (Figure 5.1). This indicates either a smooth transition in lithology over a rather long distance or a dipping interface. The dipping interface interpretation is favoured to be more realistic and is consistent with the modelled density contrast presented below in section 5.2.2. The east-northeast trend of the gravity high parallels the mapped boundary of the tonalites and granite-granodiorites indicating their association. The gravity low at the southern end of the survey area has a northwest trend which also roughly follows the mapped boundary between the granite-granodiorite suite and gneissic tonalite suite to the southwest of the survey area. A local gravity high coincides with the Benny Lake greenstone belt at the eastern edge of the survey area.
- The magnetic signature is dominated by the interpreted dykes with a prominent northwest trend and fewer dykes with a northeast trend. Low amplitude broad anomalies within the mapped granite-granodiorite suite are interpreted to indicate potential near surface heterogeneities. The mapped Benny Lake greenstone belt at the eastern edge of the survey

area has an associated magnetic signature.

Specific features identified in Figures 5.1-5.3 for the gravity data and Figures 5.4-5.6 for magnetic data are discussed below.

- The gravity low (labelled G-A1 in Figures 5.1-5.3) at the southern end of the survey area has the same northwest trend as the Sudbury mafic dykes (OGS, 2011). The edges of the source of the anomaly are not well defined in the gravity data and a lineament (labelled G-L1 in Figure 5.3) defined by a clear peak in the total horizontal derivative of the Bouguer gravity data is interpreted to define the northeastern edge. The magnetic data shows that lineament G-L1 coincides with the southern edge of a cluster of Sudbury dykes. G-L2 is a similar edge to another cluster of Sudbury dykes with a weaker associated gravity signature cutting through the centre of the gravity low. The gravity low (G-A1) is interpreted as either associated with a structural low with the thickest section of the granite-granodiorite suite or as a sign of internal density variation with the lowest densities coinciding with the gravity low.
- Although the mapped boundary between the granite-granodiorite suite and gneissic tonalite suite parallels the trend of the gravity high at the northern end of the survey area, its location is not easily defined by the gravity data and has no associated peak in the total horizontal derivative of the gravity data. Linear gravity features (labelled as G-L3, G-L4 and G-L5 in Figures 5.1-5.3) parallel the mapped edge indicating the influence from or association with the mapped boundary.
- A local gravity high (labelled as G-A2 in Figures 5.1-5.3) which falls within the mapped gneissic tonalite suite has an associated magnetic anomaly, M-A4. With a sub-circular shape and no topographic signature, the anomaly is interpreted to represent inhomogeneity in the gneissic tonalite suite rocks.
- Two linear features (labelled G-L6 and G-L7 in Figures 5.1-5.3) are inferred to trend roughly east-west, despite being rather diffuse based on a loose lining up of peaks on the total horizontal derivative of the gravity data. Although this interpretation may be uncertain, they may be taken to infer some heterogeneities within the granite-granodiorite suite. The lineaments roughly coincide with the southern edge of more magnetic units (labelled M-A1 and M-A6 respectively in Figures 5.4-5.6).
- A gravity high anomaly (labelled G-A3 in Figures 5.1-5.3) coincides with the mapped metavolcanic rocks of the Benny Lake greenstone belt. A magnetic anomaly (labelled M-A5 in Figures 5.4-5.6) coincides with the western half of the gravity anomaly indicating internal variability in the metavolcanic rocks of the greenstone belt.
- A number of linear features have been defined by peaks in the total horizontal derivative of the gravity data and have been inferred to be associated with the dykes. Linear gravity features G-L8, G-L9 and G-L10 mark southern edges of some of the northeast trending Biscotasing dykes, while G-L12 to G-L17 mark both edges of the northwest trending Sudbury and Matachewan dykes. The correlation of linear gravity features with dykes is not expected considering anomaly wavelengths in the gravity data (~ 1 km) are much broader than the widths of most dykes (typically <10's of metres). Despite this limitation these gravity features seem to correlate with a dyke-like magnetic responses, which suggests that these dykes may be either large in volume (i.e. wide) or are closely spaced.

- A set of irregular north-trending, short wavelength gravity anomalies (labelled G-A4 to G-A6 in Figures 5.1-5.3) are interpreted north of the Benny Lake greenstone belt. The short wavelength of the anomalies indicate that they are associated with shallow geological sources. They have no associated magnetic signature or obvious topographic expression. The pattern of the anomalies suggests they are due to related shallow geological structures. With the anomalies being located in the extended area of the survey with wider flight line spacing, a 6 km full wavelength low pass filter was applied to the entire grid (appropriate for filtering the wider line spacing) and still resulted in well-developed linear gravity features G-A4 to G-A6 which may suggest a geological source.
- Even though there are no systematic variations or patterns in the short wavelength magnetic fabric (e.g. Figures 4.25 and 4.26 showing the tilt angle of the reduced to the pole magnetic anomaly data) thus suggesting fairly uniform magnetic susceptibilities within the granite-granodiorite suite, broad low amplitude magnetic highs have been identified (labelled as M-A1 to M-A4 in Figures 5.4-5.6) and interpreted to indicate the presence of some smooth internal heterogeneity. The southern edge of area M-A1 has an associated gravity anomaly labelled as G-L6 while the area M-A4 has an associated gravity anomaly labelled as G-A2. The broad magnetic anomalies generally fall in the northern half of the survey area closer to the boundary with the gneissic tonalite suite.
- Area M-A5 in Figures 5.4-5.6 coincides with the western end of the mapped Benny Lake greenstone belt covered by the survey. The eastern end covered by the survey has a more subdued associated magnetic signature. A magnetic anomaly (labelled as M-A6 in Figures 5.4-5.6) has been interpreted as a possible extension of the Benny Lake greenstone belt to the west. Both area M-A5 and M-A6 have no obvious topographic expressions. The wider, area M-A5, has a strong associated gravity anomaly while the narrower, area M-A6, does not. Both features lie to the south and appear to be influenced by a lineament (labelled as M-L1 in Figures 5.4-5.6) associated with the northern extension of the Flack Lake fault (OGS, 2011). A neighbouring magnetic anomaly (labelled as M-A7 in Figures 5.4-5.6) though similar in magnetic signature to the other two, has a topographic correlation which could in part explain its origin and it also falls north of the Flack Lake fault off the trend of the mapped greenstone belt thus might not be as economically significant as the interpreted greenstone belts.
- A mapped lens of metavolcanics at the north-western edge of the survey area has an associated magnetic low anomaly (labelled as M-A8 in Figures 5.4-5.6). The anomaly falls outside the gravity survey limits.
- The dominant linear anomalies in the magnetic signature are interpreted to be dyke swarms with typical short wavelength magnetic high signatures. A number of isolated dyke like anomalies are identified in the survey area such as the north-south trending anomaly near the centre of the survey (labelled M-L4 in Figures 5.4-5.6) and the east-west trending anomaly at the northern end of the survey area (labelled M-L5 in Figures 5.4-5.6). A topographic low lineament runs parallel to the magnetic high anomaly M-L4 at its northern half and is interpreted to indicate a related fault. The magnetic high anomaly M-L5 has a coincident topographic low lineament indicating easier weathering of the interpreted dyke compared to country rocks.
- Linear truncations in the topographic data with associated magnetic signatures have been identified and presented in Figures 5.4-5.6. These typically have an associated magnetic low

anomaly. The lows are interpreted to be due to either or a combination of, loss/alteration of magnetic minerals along fault zones or terrain effect from weakly magnetic near surface units. Faults are noticeable when the lineaments cut across interpreted dykes reducing their positive magnetic anomalies while terrain effects are more noticeable when they coincide with edges of topographic features. One of these lineaments parallels the northern extension of the Flack Lake fault (labelled as M-L1 in Figures 5.4-5.6) while lineaments M-L2 and M-L3 trend sub-parallel to M-L1 with an east west trend close to that of the Benny Lake greenstone belt.

5.2 Preliminary 2.5D Modelling

The purpose of the 2.5D modelling is to develop an idea of the relatively deep and relatively shallow parts of the granite-granodiorite suite of the Ramsey-Algoma granitoid complex and a rough approximation of the depth to the bottom of the Ramsey-Algoma granitoid complex. The preliminary 2.5D modelling uses the gravity, magnetic and digital elevation data sets, accompanied with constraints from the qualitative interpretation of the geophysical data and the mapped bedrock geology to provide a preliminary image of the subsurface along the two profile lines shown in Figures 5.7 and 5.8.

For the purpose of the initial modelling, density and magnetic susceptibility values were assigned to the bedrock units mapped on the surface and to the bedrock units at depth based on available information. In the Elliot Lake and Blind River area, several surface bedrock density and magnetic susceptibility values have been compiled from available literature (data sources discussed in Section 3) and incorporated as constraints into the models. These assumed density and magnetic susceptibility values should be considered as approximate values.

In order to assess the sensitivity of the assigned density and magnetic susceptibilities on the modelled geometry and thickness of the bedrock units, a series of alternative models were considered for the profile lines. The initial models assume uniform rock densities for the granite-granodiorite suite and the gneissic tonalite suite and varied the geometry of the contact at the base of the granite-granodiorite suite overlying the gneissic tonalite suite to fit the model to the observed data. On the other hand, the alternative models have a relatively horizontal contact and therefore varied the rock density values within the granite-granodiorite suite in order to fit the model to the observed data. Both model approaches provide a good fit to the data. The resulting 2.5D models can give an idea of the amount of structural relief needed if one assumes uniform rock densities for main units modelled and alternatively density variations needed if one assumes minimal relief with the most likely scenario falling between the two.

It is important to emphasize that the accuracy of these preliminary models is limited at this early stage of the assessment due to limited availability of bedrock densities and magnetic susceptibilities that are key for constraining the model. It is anticipated that the preliminary 2.5D models would be revised and refined if more field data is collected in the future.

5.2.1 Model Descriptions

The preliminary 2.5D forward modelling of gravity and magnetic data was carried out using GMSYS Software (copyright Northwest Geophysical Associates Inc. 2006) running under Geosoft Oasis Montaj (Geosoft, 2016). The modelling considered two profile lines. The locations of the profile lines are shown in Figure 5.7 superimposed on the Bouguer gravity, and in Figure 5.8 superimposed on the

total magnetic intensity reduced to the pole. The coordinates of the start and end points for each of the profile lines are listed in Table 5.1

Table 5.1: Coordinates of 2.5D Model Profiles (UTM 17N, NAD83)

Profile Line	Start		End	
	UTM X	UTM Y	UTM X	UTM Y
1	412125	5128628	412125	5229375
2	398185	5186000	437125	5186000

The process for constructing the models was as follows:

- The location and extent of profile models was taken into consideration when the survey was originally planned. Regional trend lines extend past the northern, southern and eastern boundaries of the main area of the survey block to capture the regional features outside of the area of high-resolution data. The two profile lines were chosen to include the regional trends.
- The profiles were modelled from Bouguer gravity and the total magnetic intensity data. It is possible to model either Free-Air or Bouguer gravity. Both approaches are valid, the difference is that topographic effects have been corrected in the Bouguer gravity, assuming a single density within the range of relief (2.67 g/cm^3 in this instance). Some terrain effects will still occur in the Bouguer gravity where density varies from the assumed value within the range of relief. The best choice depends on the degree to which the single density terrain corrections are applied and correctly handled. The model results should be essentially the same with either approach.
- The gravity was modelled first to determine the broad large scale features and the magnetic data were used to refine the model and to help model the overall shape of smaller geological units. Long wavelength magnetic trends associated with large rock units were modelled as opposed to individual discrete anomalies and, as such, only the most prominent dykes were included to fit the observed data.
- Densities for individual greenstone belts or intrusives were assumed to be uniform throughout. This assumption was only violated if it was impossible to model the gravity using uniform densities. Thus the gravity anomalies were generally accounted for by varying the shapes of the rock units after initial density assumptions were made, rather than by varying the densities within the rock units.
- Depth trend solutions of the Bouguer gravity and magnetic data were used for determining locations and dips of faults and lithological contacts.
- Available geologic mapping (OGS, 2011) was used to determine the location of the points at which geological boundaries occurred along the surface of the models.
- Density information from the OGS PETROCH database (Haus and Pauk, 2010) and the GSC rock property database (GSC, 2015), as discussed in Section 3, was incorporated into the models. The densities and ranges used in the models are listed in Table 5.2.

- Magnetic susceptibilities values for formations in the area were estimated using those from the OGS, Geological, Geochemical and Geophysical Database from the Elliot Lake Area, Southern and Superior Provinces, Ontario (Easton, 2013), which is known as Miscellaneous Release – Data 305, over an area to the south of the main survey area. Mean susceptibilities were initially assigned to the different units and adjusted to best match the amplitude of the magnetic anomalies.
- In seeking to model magnetic variations within individual rock units, near vertical boundaries were initially used in the absence of other indications. These boundaries were then adjusted to best fit the data. Trend analysis solutions were only used in part in a corroborative manner to position some dyke or model block edges. Trend analysis solutions which occur no more than 0.5 km away from the model line are shown in the 2.5D model figures.
- The overburden has not been included in the modelling. It is deemed to be sufficiently thin that its effect on the gravity and magnetic anomalies is negligibly small for modelling purposes.
- Where the 2.5D model lines intersect, the geological boundaries, densities, and magnetic susceptibilities have been made to coincide at the model intersection points

Table 5.2: Densities and magnetic susceptibilities used in the 2.5D models.

Layer	Density (g/cm³)	Magnetic Susceptibility (S. I.)
<i>Granite-granodiorite</i>	<i>2.57-2.62</i>	<i>0-0.010</i>
<i>Gneissic tonalite</i>	<i>2.68-2.70</i>	<i>0.010</i>
<i>Mafic metavolcanics</i>	<i>2.91</i>	<i>0-0.041</i>
<i>Gabbro – East Bull Lake intrusive</i>	<i>2.87</i>	<i>0-0.011</i>
<i>Syenite – Pariesian Lake Syenite</i>	<i>2.67</i>	<i>0-0.024</i>
<i>Sandstone – Lake Huron sediments</i>	<i>2.65</i>	<i>0</i>
<i>Dyke</i>	<i>2.62-2.69</i>	<i>0-0.027</i>
<i>Undifferentiated basement</i>	<i>2.69</i>	<i>0</i>

5.2.2 Model Results

This section discusses the results of the 2.5D modelling for the two profile lines considered. It is assumed in all models that the granite-granodiorite suite of the Ramsey-Algoma granitoid complex intrudes the gneissic tonalite suite and both are underlain by a uniformly dense unit (density of 2.69 g/cm³) defined as an undifferentiated basement. Alternative models were developed to investigate different geological scenarios.

The 2.5D modeling results for the Elliot Lake and Blind River area are shown on Figures 5.9 to 5.12. The figures show a plan view along the profile line (e.g. top panel Figure 5.9) at an appropriate constant model elevation, in order to show the distribution of bedrock units that are included in the model calculations perpendicular to the strike of the profile line. The gravity view (e.g. second panel

Figure 5.9) shows the observed gravity data along the profile line, as well as the calculated gravity data, the misfit and the RMS error (i.e. root mean square error). The RMS error is used as a measure of the difference between the observed gravity data and the modelled gravity results. The next gravity view (e.g. third panel Figure 5.9) shows the assignment of the rock density values to each of the bedrock units in the model. The magnetic view (e.g. fourth panel Figure 5.9) shows the observed and calculated magnetic data, as well as the misfit and RMS error between the two data sets. The next magnetic view (e.g. fifth panel Figure 5.9) shows the assignment of the magnetic susceptibility values to each of the bedrock units in the model. The structural view provides the overall interpretation of the modelled results, which are coloured based on geological unit (e.g. sixth panel on Figure 5.9). Each of these model views shows the depth on the y-axis in kilometers below mean sea level (MSL).

5.2.2.1 Initial Model Line 1 (Figure 5.9)

As shown in Figures 5.7 and 5.8, Line 1 runs from south to north, along the extension traverses beyond the main survey block, starting south of and transecting the East Bull Lake intrusion and then the transition from the gneissic tonalite suite into the granite-granodiorite suite of the Ramsey-Algoma granitoid complex. The profile ends back in the gneissic tonalite suite along extension lines north of the main survey block.

- Generally, the observed gravity signal of Line 1 consist of a roughly centrally located broad wavelength low response within the mapped granite-granodiorite suite with highs to the north and south which fall within the mapped gneissic tonalite suite. While the gravity signal increases almost linearly from the central low going northwards, it increases at a higher rate and in a stepping fashion going southwards, suggesting a more complex geology in the southern half of the line. The magnetic profile on the other hand is highly variable and dominated by high amplitude, short wavelength anomalies interpreted to be mostly due to dyke swarms and also the Parisien Lake Syenite intrusive near the southern end of the line. Low amplitude broad variations of the magnetic anomaly can be inferred and are interpreted to represent heterogeneities within units of the Ramsey-Algoma granitoid complex.
- With a fixed rock density of 2.62 g/cm^3 for the granite-granodiorite suite and a fixed density of 2.68 g/cm^3 for the gneissic tonalite suite, depth to the bottom of the granite-granodiorite suite mimics the gravity signal of Line 1. The central gravity low requires a depth to bottom of up to 16 km. This also represents the minimum depth to a flat topped underlying undifferentiated unit below the gneissic tonalite suite. An almost linear ramp to the surface is modelled for the base of the granite-granodiorite suite going northwards from the central gravity low. To maintain the mapped contact with the surface, the base curves as it approaches the surface. Moving the surface boundary farther north from the mapped location would maintain the near linear slope of the contact to the surface.
- Southwards from the middle of the central gravity low (located near the 45 km station along the line), the gravity anomaly increases until the 35 km station and then it slightly flattens out from the 35 km station until the 22 km station. It then increases again more rapidly from the 22 km station until the 14 km station and flattens again to the beginning of Line 1. Both rapid increases in the gravity call for steep contacts in the models between the granite-granodiorite suite and the gneissic tonalite suite with the more rapid increase between the 14 km and 22 km stations requiring the denser gneissic tonalite suite to overly the less dense granite-

granodiorite suite. The relatively flat section in the gravity between the 22 km and 35 km stations is modelled with a depth to base of the granite-granodiorite suite around 6 km.

- The Parisien Lake Syenite is mapped roughly between the 11 km and 13 km stations. A well-defined density for the syenites of 2.67 g/cm^3 from 18 sample points does not produce the observed gravity lower within the surrounding gneissic tonalite suite with a poorly defined density of 2.68 g/cm^3 from only three sample points. This called for a slight increase of the local density of the gneissic tonalite suite to 2.70 g/cm^3 within a block extending from the beginning of the Line1 to the contact with the granite-granodiorite suite around the 21 km station. The Parisien Lake Syenite is modelled as extending to a depth of 2.5 km below MSL, a value strongly depended on the density of surrounding gneissic tonalite suite. The depth to base of the local block of the gneissic tonalite suite with a density of 2.7 g/cm^3 can be handled in two approaches. Firstly one could assume and model an influence on the observed gravity anomaly from the Huronian Supergroup units to the east and west of the line, with off line model blocks of higher density. This would result in a depth to the block around 6 km similar to the granite-granodiorite suite to the north as shown in Figure 5.9. Alternatively assuming no influence of off-line Huronian Supergroup units requires the block to be extended down to the depth of the undifferentiated basement unit at 16 km depth.
- Between the 13 km and 21 km stations, Line 1 transects units of the East Bull Lake intrusives and outliers of the Huronian Supergroup. A well-defined density of gabbros of 2.87 g/cm^3 from 92 sample points was used to model the East Bull Lake intrusives and a less well defined 2.91 g/cm^3 for the metavolcanic rocks and 2.65 g/cm^3 for the sandstones of the Lake Huron sediments. The model calls for fairly thin units of less than 200 m for the intrusives and metavolcanics and even thinner units of the low density sandstones.
- Line 1 transects mapped migmatized supercrustal rocks between the 90 km and 94 km stations with barely any noticeable gravity response. A thin sliver with a density of 2.8 g/cm^3 was used in the model. A sharp drop-down in the gravity near the end of the line within the gneissic tonalite suite has no mapped associated geological feature. A mapped Archean granitoid farther to the north is modelled as a possible cause underlying the exposed gneissic tonalites and with a density of 2.62 g/cm^3 .
- Initially average magnetic susceptibilities for the different units were assigned to formations in the model defined using only the gravity data. The model magnetic susceptibilities are then modified to improve the fit to the observed magnetic data, following which the shapes of the bodies are modified to produce a best fit of both the gravity and magnetic data. In places, units of the same formations with the same densities are partitioned to allow for the more varied magnetic susceptibilities. Dyke like features intersected at an oblique angle by the profile tend to be overestimated in thickness by the modelling of magnetic data and underestimated in density by the modelling of gravity data to produce a fit to the data.
- The Parisien Lake Syenite is modelled with the highest magnetic susceptibilities on Line 1 of 0.024 SI with the dykes only peaking at 0.013 SI most likely due to the overestimated dyke thicknesses in the models. The central gravity low coincides with a near zero magnetic susceptibility unit within the granite-granodiorite suite stretching from the 38 km station to just over the 61 km station. The magnetic susceptibility increases marginally to 0.003 SI for the section of the granite-granodiorite suite to the south while increasing to 0.010 SI for both the granite-granodiorite suite and the gneissic tonalite suite units to the north. Near vertical

boundaries between the magnetic units are modelled. The northern contact coincides with gravity lineament G-L6 which coincides with the southern boundary of the magnetic area M-A1.

5.2.2.2 Alternative Model Line 1 (Figure 5.10)

Line 1 was also modelled using a variable density for the granite-granodiorite suite in order to reduce the excessive relief at its base contact with the underlying gneissic tonalite suite.

- All contacts within this model are the same as those presented in the initial model of Line 1, except for the base of the granite-granodiorite suite.
- The central gravity low which coincides with a low magnetic susceptibility unit within the granite-granodiorite suite, defined on Line 1 stretching from the 38 km station to just over the 61 km station, was remodelled as having a constant and lower density of 2.57 g/cm³ with the rest of the granite-granodiorite suite at 2.62 g/cm³. This resulted in a reduction of the depth to the underlying gneissic tonalite suite, giving a near constant depth ranging from about 5 km at the northern end to 6 km in the south. Slight changes in dips of the contact of the less dense unit with the denser units was necessary to maintain a good fit to the observed gravity data. The model fit to the observed magnetic data is essentially unchanged for the short wavelength signature. The model changes, occurring at depths greater than 5 km, produce broad small amplitude shifts in modelled data which slightly improve the overall fit. No changes in magnetic susceptibilities of the different units were needed.
- The dipping interface at the northern edge of the granite-granodiorite suite with the gneissic tonalite suite was maintained as a simpler and more likely option to having multiple near vertical contacts and represents a transition zone of smoothly increasing density from the 65 km station to 81 km station.
- With the deepest part of the granite-granodiorite suite around 6 km below MSL a flat topped undifferentiated zone underlying the gneissic tonalite suite can be placed at any greater depth without affecting the model fit. The block of slightly denser gneissic tonalite suite units at the beginning of the Line 1 (stretching from the beginning of the line to the 21 km station) has the same characteristics as the initial model of Line 1 with a depth to base of around 6 km if Huronian Supergroup units are incorporated, as shown in Figure 5.10 or extending much deeper if no influence of the Huronian Supergroup units is assumed.
- A model fit can also be obtained by assigning the shallower granite-granodiorite suite a uniform density of 2.62 g/cm³ and decreasing the density of sections of the underlying gneissic tonalite suite also to 2.62 g/cm³

5.2.2.3 Initial Model Line 2 (Figure 5.11)

As shown in Figures 5.7 and 5.8, Line 2 runs west to east from near the centre of the granite-granodiorite suite at the western edge of the main survey block to the western section of the mapped Benny Lake greenstone belt along regional trend lines located at the eastern edge of the main survey block.

- Generally, the observed gravity signal of Line 2 shows a broad wavelength low response

covering the western half of the line within the mapped granite-granodiorite suite. The low is part of the centrally located broad wavelength gravity low response on Line 1. The gravity response gradually increases eastwards to two gravity peaks within the mapped Benny Lake greenstone belt. The magnetic profile is highly variable and dominated by short wavelength anomalies interpreted to be mostly due to dyke swarms and also a high associated with the western half of the mapped Benny Lake greenstone belt covered by the survey. Clear low amplitude broad variations of the magnetic anomaly can also be inferred and are interpreted to represent heterogeneities within units of the Ramsey-Algoma granitoid complex.

- With a fixed rock density of 2.62 g/cm^3 for the granite-granodiorite suite and a fixed density of 2.68 g/cm^3 for the gneissic tonalite suite, depths to bottom for the granite-granodiorite suite have been modelled to extend to 8 km below MSL near the centre of the line. The depth shallows gently westwards and more rapidly eastwards under the Benny Lake greenstone belt. Extension of the granite-granodiorite suite under the mapped Benny Lake greenstone belt and its surrounding gneissic tonalite suite was required to produce a fit but both its top and bottom are poorly constrained.
- The gravity response of the Benny Lake greenstone belt was modelled using a constant density of 2.91 g/cm^3 for the meta-volcanics thus the resulting shape mimics the observed gravity response. The model has a magnetic western western lobe (between the 26 km and 31 km stations) with a thickness around 600 m and a smaller eastern lobe (between the 32 km and 36 km stations) with a thickness around 300 m without an obvious associated magnetic response. The modelled breaks in the greenstone belt seem to correlate with mapped northwest trending crosscutting faults (OGS, 2011).
- Initially average magnetic susceptibilities for the different units were assigned to formations in the model defined only using the gravity data. The model magnetic susceptibilities are then modified to improve the fit to the observed magnetic data, following which the shapes of the bodies are modified to produce a best fit of both the gravity and magnetic data. In places, units of the same formations with the same densities are partitioned to allow for the more varied magnetic susceptibilities.
- Units with near vertical edges have been modelled within the granite-granodiorite suite with susceptibilities ranging from 0 to 0.09 SI with most of the blocks having a susceptibility of 0.006 SI. On Line 1, Line 2 runs close to and over the dipping boundary between two units with magnetic susceptibilities of zero and 0.010 SI, setting the limits for magnetic susceptibilities on Line 2.
- The dyke modelled between the 2.4 km and 4 km stations has a single associated magnetic high anomaly in the data gridded at 250 m grid cell size while the 25 m grid cell size data identifies it as a set of at least 4 much thinner dykes. The modelled magnetic susceptibility of 0.006 SI is an averaged value for both the dyke and granite-granodiorite suite host rocks indicating that the mafic dykes have much higher magnetic susceptibilities than as modelled.
- The magnetic signature associated with the western lobe of the Benny Lake greenstone belt (defined using gravity data between the 26 km and 31 km stations) has the strongest associated magnetic signature on Line 2. The magnetic anomaly has sharp peaks at both ends centred at the 27 km and 30 km stations. Though the peaks have been modelled to represent susceptibility variations within the meta-volcanic units of the Benny Lake greenstone

belt, they could equally well be due to either Sudbury or Matachewan dykes which roughly trend northwest.

5.2.2.4 *Alternative Model Line 2 (Figure 5.12)*

Line 2 was also modelled to incorporate a variable density for the granite-granodiorite suite required to reduce the strong relief at its base contact with the underlying gneissic tonalite suite observed in Line 1.

- On Alternative Model Line 1 (Figure 5.10), Line 2 cuts close to and over a dipping edge between two units of the granite-granodiorite suite with densities of 2.57 g/cm^3 and 2.62 g/cm^3 and a depth to base of 5 km. The base of the granite-granodiorite suite was set to 5 km to coincide with Alternative Model Line 1 and then the density of the whole granite-granodiorite suite was adjusted along the line until a close fit was obtained. A density of 2.6 g/cm^3 which lies between the limits set on Alternative Model Line 1 produces an acceptable fit.
- All contacts within this model are the same as those presented in the initial model of Line 2, except for the base of the granite-granodiorite suite. Some minor changes in dips of some of the near vertical interfaces occur. The lower density of 2.6 g/cm^3 for the granite-granodiorite suite resulted in a levelled base contact at about 5 km.
- The model fit to the observed magnetic data is essentially unchanged for the short wavelength signature. The model changes, occurring at depths greater than 5 km, produce broad small amplitude shifts in modelled data which slightly reduced the overall fit. No changes in magnetic susceptibilities of the different units were judged critical for the model.
- With the deepest part of the granite-granodiorite suite around 5 km below MSL a flat topped undifferentiated zone underlying the gneissic tonalite suite can be fitted at any greater depth without affecting the model fit.

6 Summary of Results

The following provides a summary of the qualitative observations and the preliminary 2.5D modelling of the geophysical data, focusing on the areas identified during Phase 1 as being potentially suitable within the Ramsey-Algoma granitoid complex. The survey allowed for a characterization of the distinctive local gravity and magnetic signatures of the granite-granodiorite suite of the complex and the Benny Lake greenstone belt.

- A gravity low at the southern end of the survey either represents the deepest portion of a uniformly dense granite-granodiorite suite or a local alternate phase of emplacement with a slightly lower density. A gravity high at the northern end represents a dipping transition from a uniformly dense granite-granodiorite suite to a uniformly dense gneissic tonalite suite. In all scenarios the base of the Ramsey-Algoma granitoid complex has been modelled no shallower than 5 km below MSL.
- The granite-granodiorite suite shows internal low amplitude long wavelength variations in magnetic anomalies highlighting some degree of lithological heterogeneity. The magnetic fabric is dominated by topographic effects from the granite-granodiorite suite rocks or by cross cutting dyke swarms.
- The survey covered the western end of the mapped Benny Lake greenstone belt. The associated high gravity anomaly indicate two lobes of the belt which can also be correlated with mapped geology. The magnetic signature of the greenstone belt shows internal variations with the western lobe of the belt more magnetic than the eastern lobe. A high magnetic anomaly, lying south of the Flack Lake fault and along the trend of the Benny Lake greenstone belt has been identified as a possible western extension of the greenstone belt.
- A small gravity high at the northwestern corner of the survey block, lying within the gneissic tonalite suite has been interpreted as representing lenses of metavolcanics. The gravity anomaly has a small associated magnetic high anomaly. Curved, north south trending, short wavelength gravity anomalies at the eastern edge of the survey block are interpreted as being caused by a shallow geological source. With no associated topographic and magnetic signature the sources are still yet to be identified.

The 2.5D models are viewed as preliminary primarily due to the limited availability of bedrock densities and magnetic susceptibilities that are key for constraining the model. More field data would allow for revision and refinement of the models.

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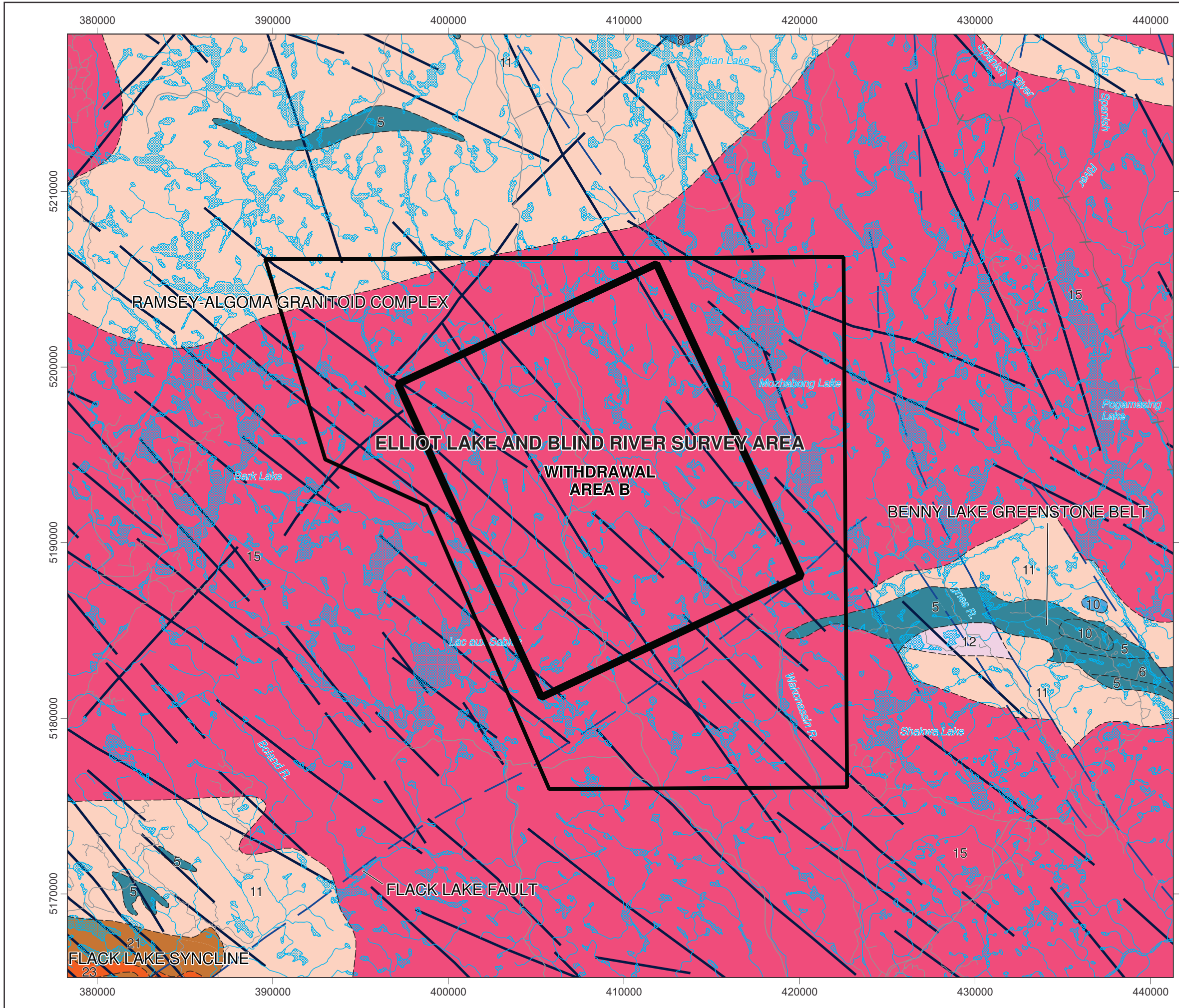
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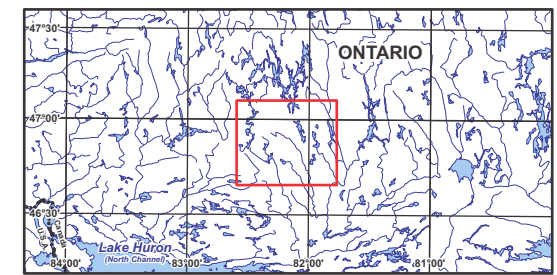
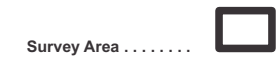
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Survey Location

BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

Scale 1 : 215 000



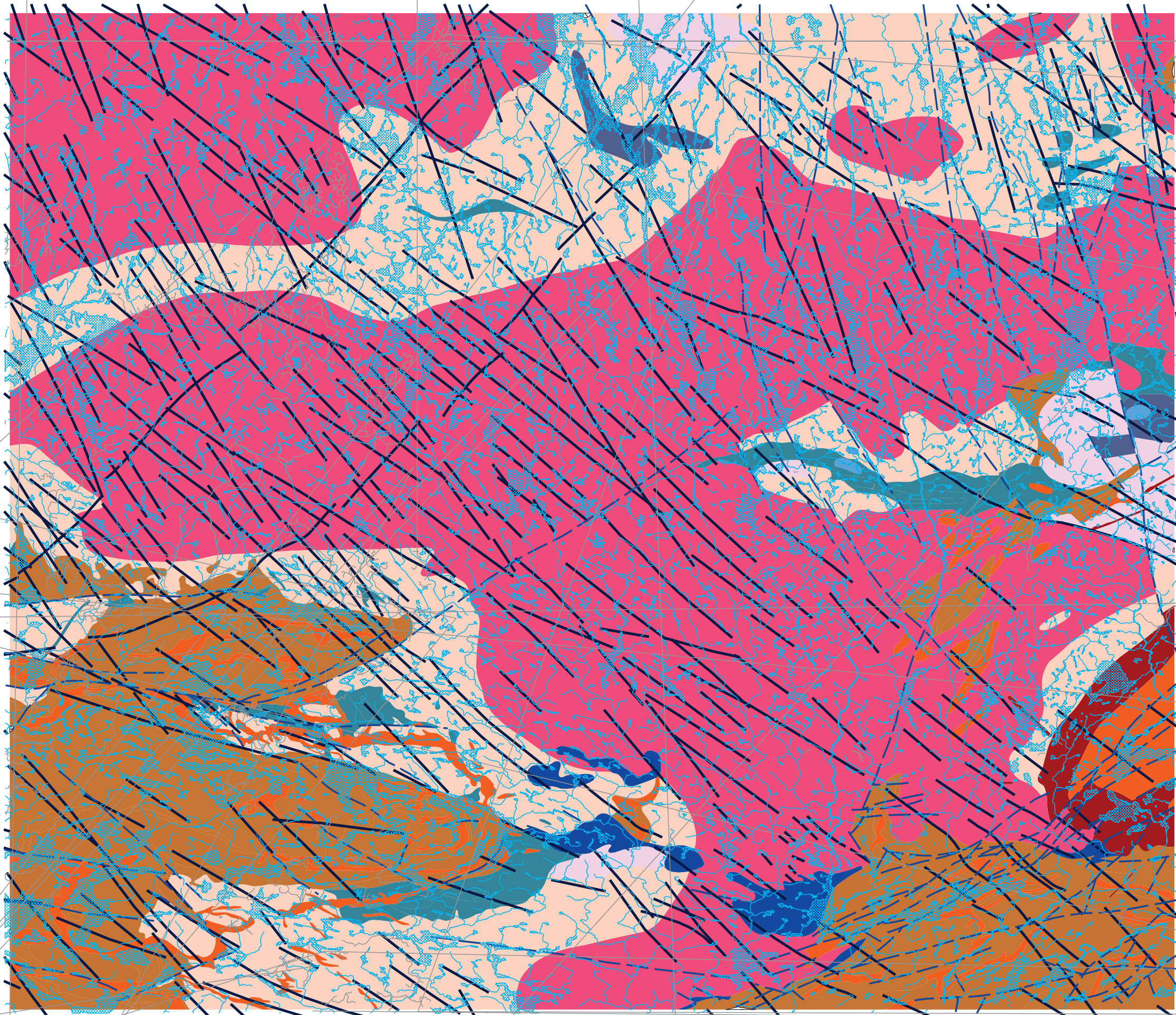
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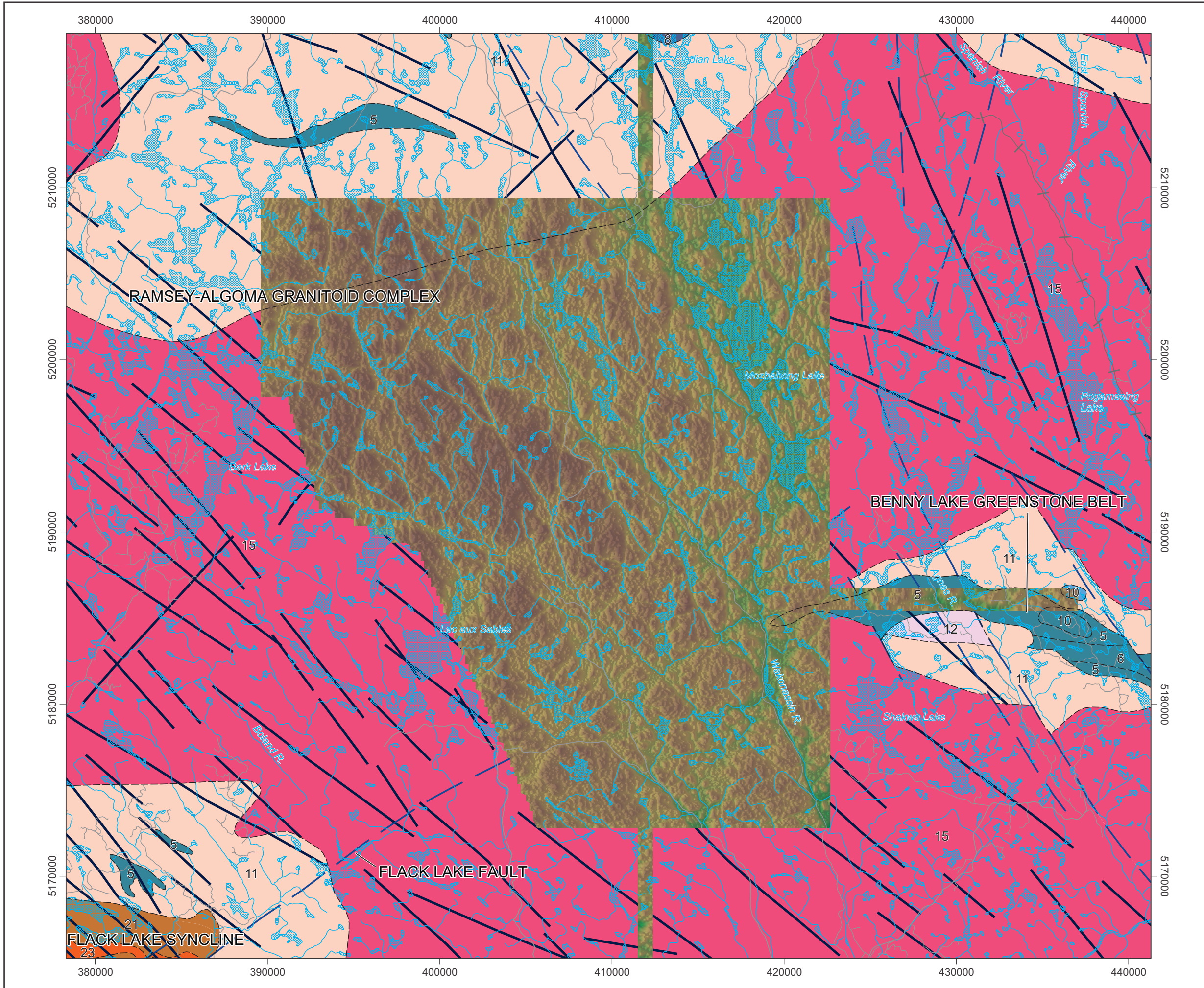
Elliot Lake and Blind River Area, Ontario 2016

Survey Area

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GIS	YC	26/06/2017	FIGURE: 1.1
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QC	MB	29/06/2017	







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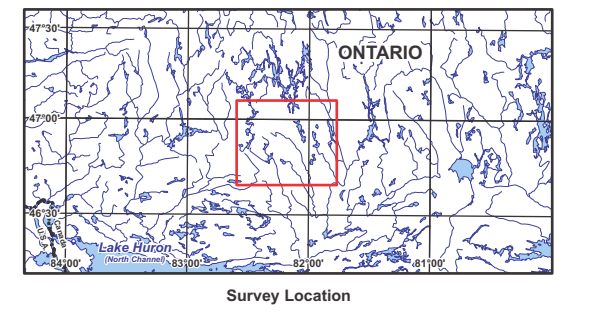
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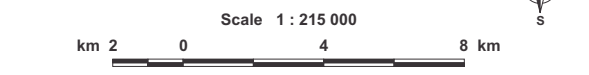
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m



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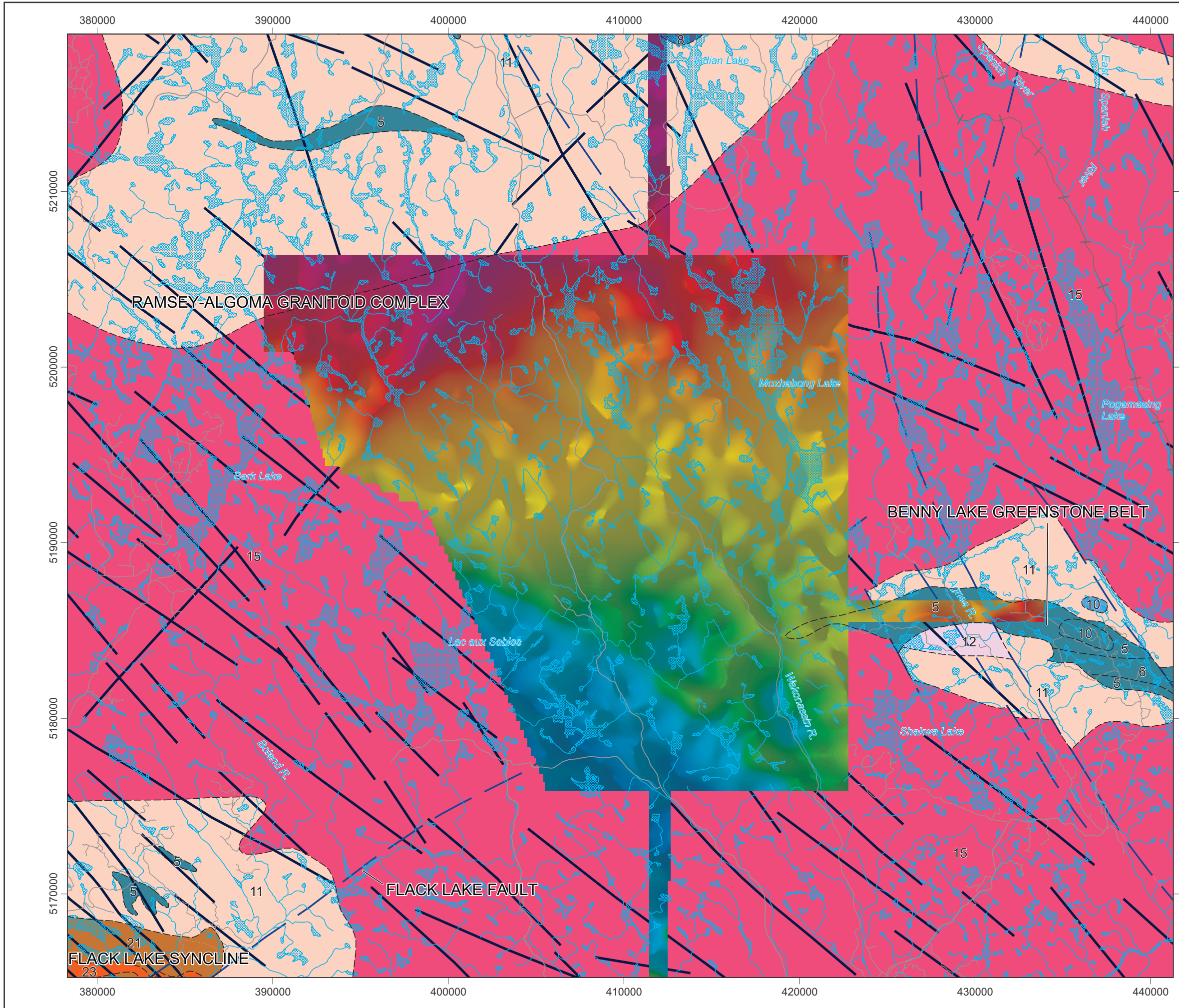


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Digital Elevation Model (25 m cell)

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	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



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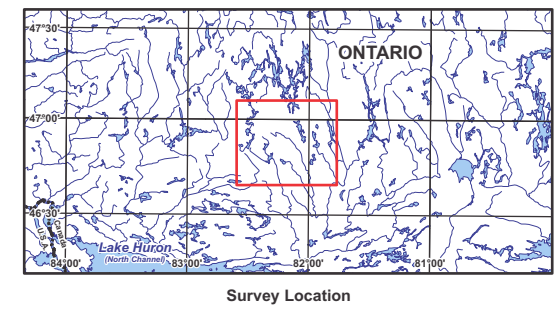
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Bouguer Density: 2.67 g/cm³

mGal



BASE DATA: National Topographic Database - NRCAN
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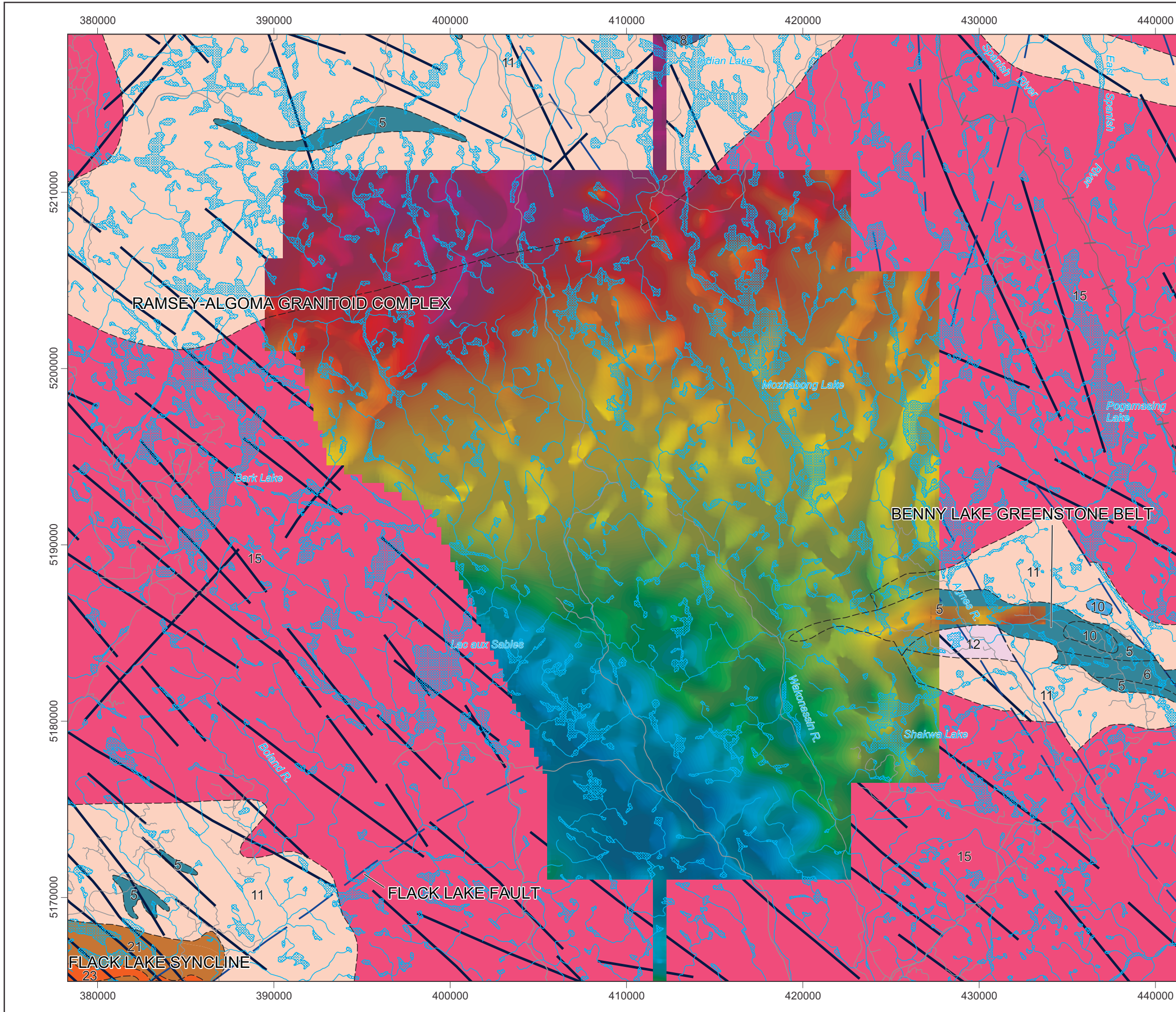


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Elliot Lake and Blind River Area, Ontario 2016

Bouguer Gravity (Density: 2.67g/cm³) (25 m cell)

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	GIS	YC	26/06/2017	FIGURE: 4.1
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



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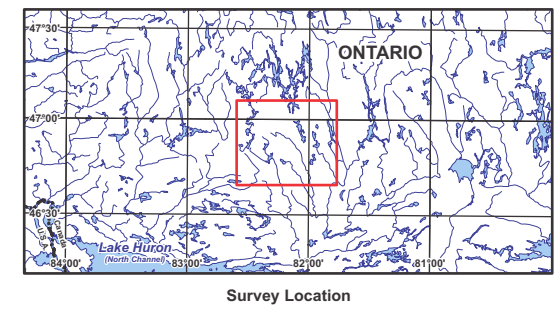
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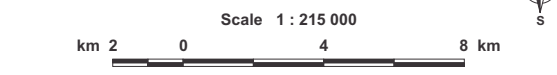
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mGal



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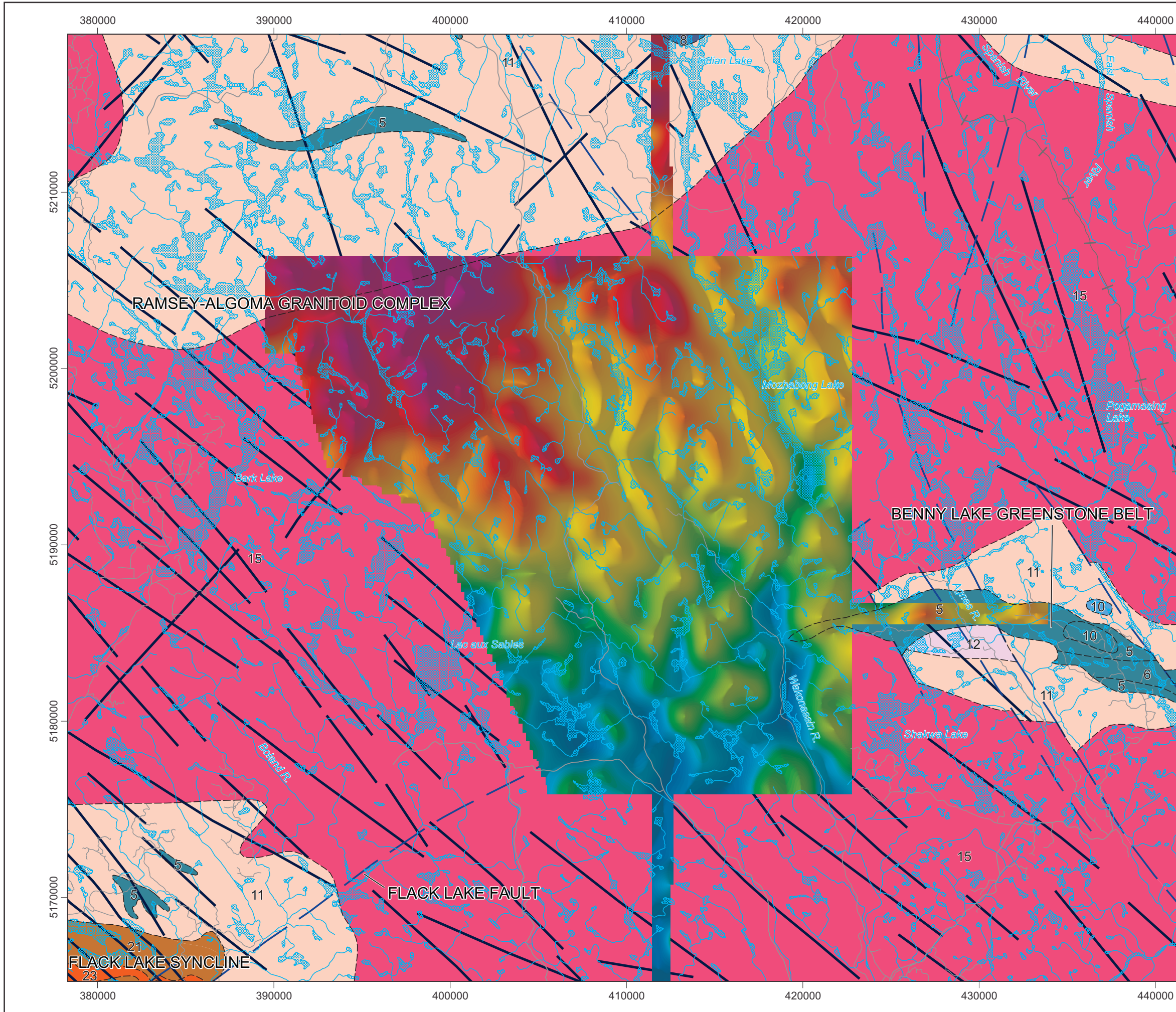


**Airborne Geophysics
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Elliot Lake and Blind River Area, Ontario 2016

Bouguer Gravity (Density: 2.67g/ cm³) (250 m cell)

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	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



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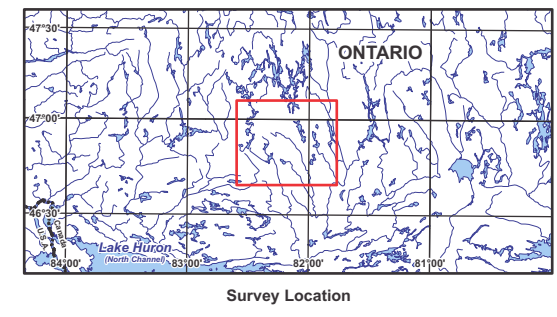
6, 5: Metavolcanic rocks

Map Parameters

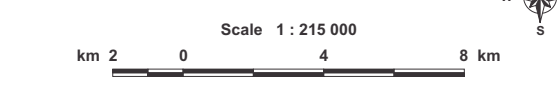
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mGal



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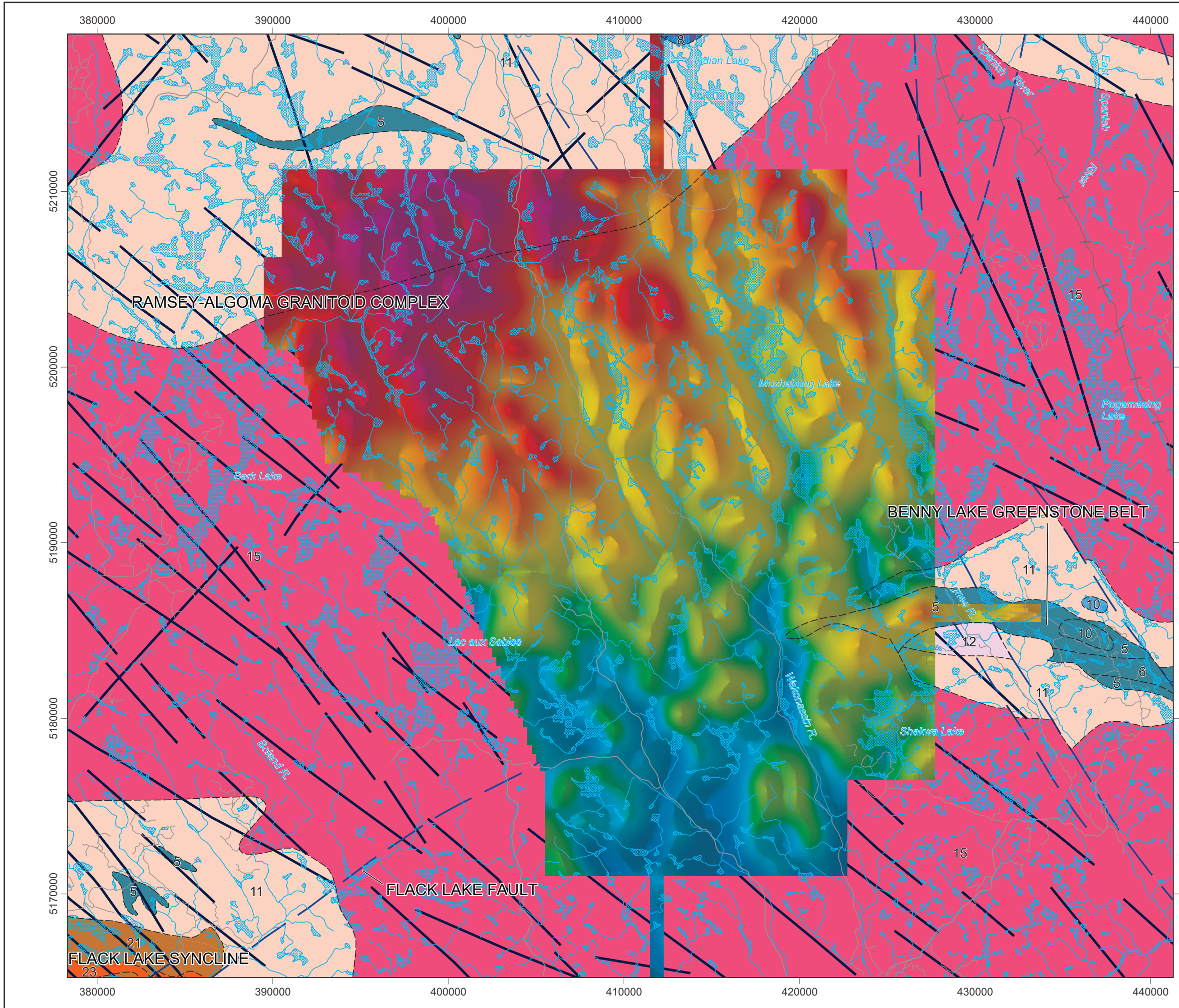


**Airborne Geophysics
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Elliot Lake and Blind River Area, Ontario 2016

Free Air Gravity (25 m cell)

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	GIS	YC	26/06/2017	FIGURE: 4.3
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



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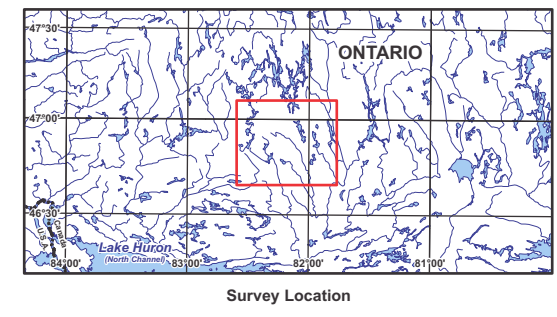
6, 5: Metavolcanic rocks

Map Parameters

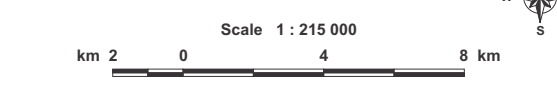
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mGal



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 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

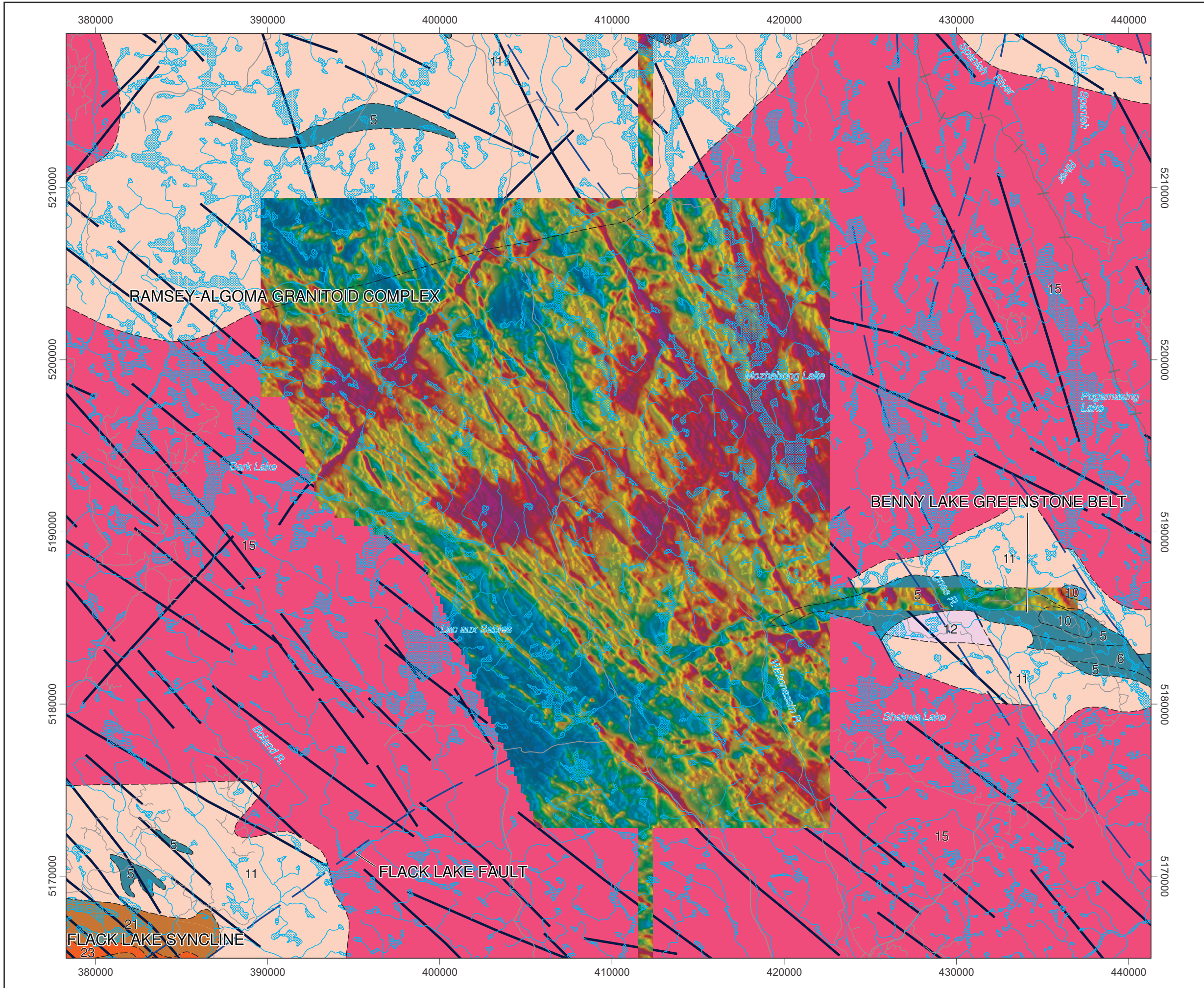


**Airborne Geophysics
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Elliot Lake and Blind River Area, Ontario 2016

Free Air Gravity (250 m cell)

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	QC	MB	29/06/2017	



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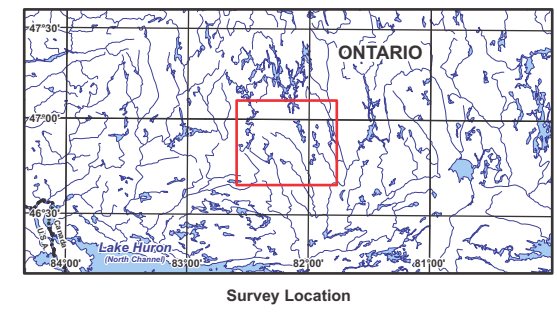
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6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

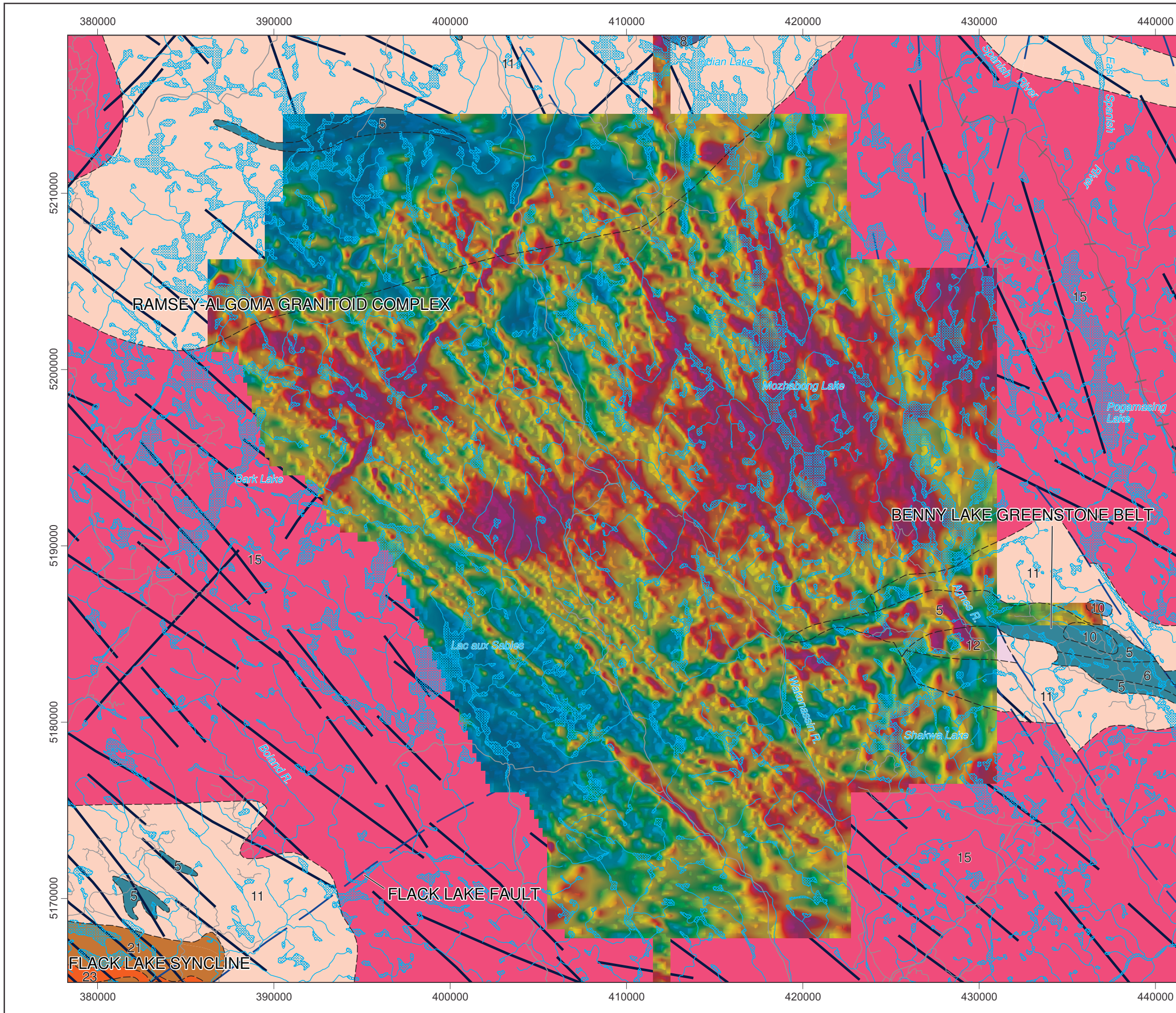


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Magnetic Intensity (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.5
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

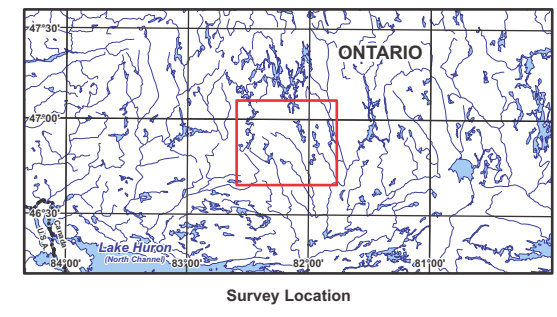
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

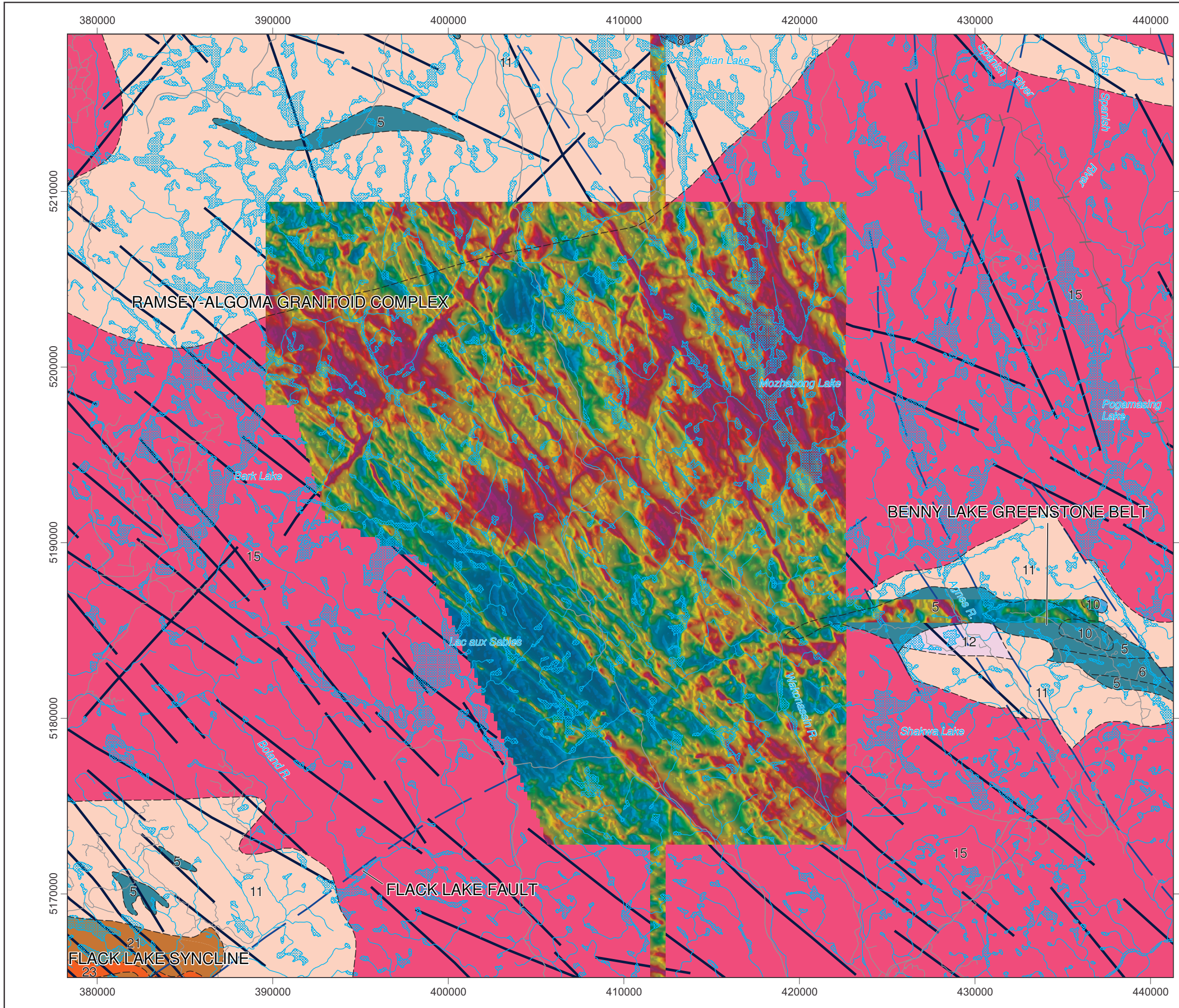


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Magnetic Intensity (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.6
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

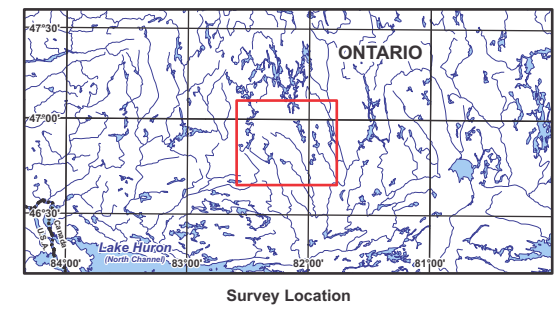
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

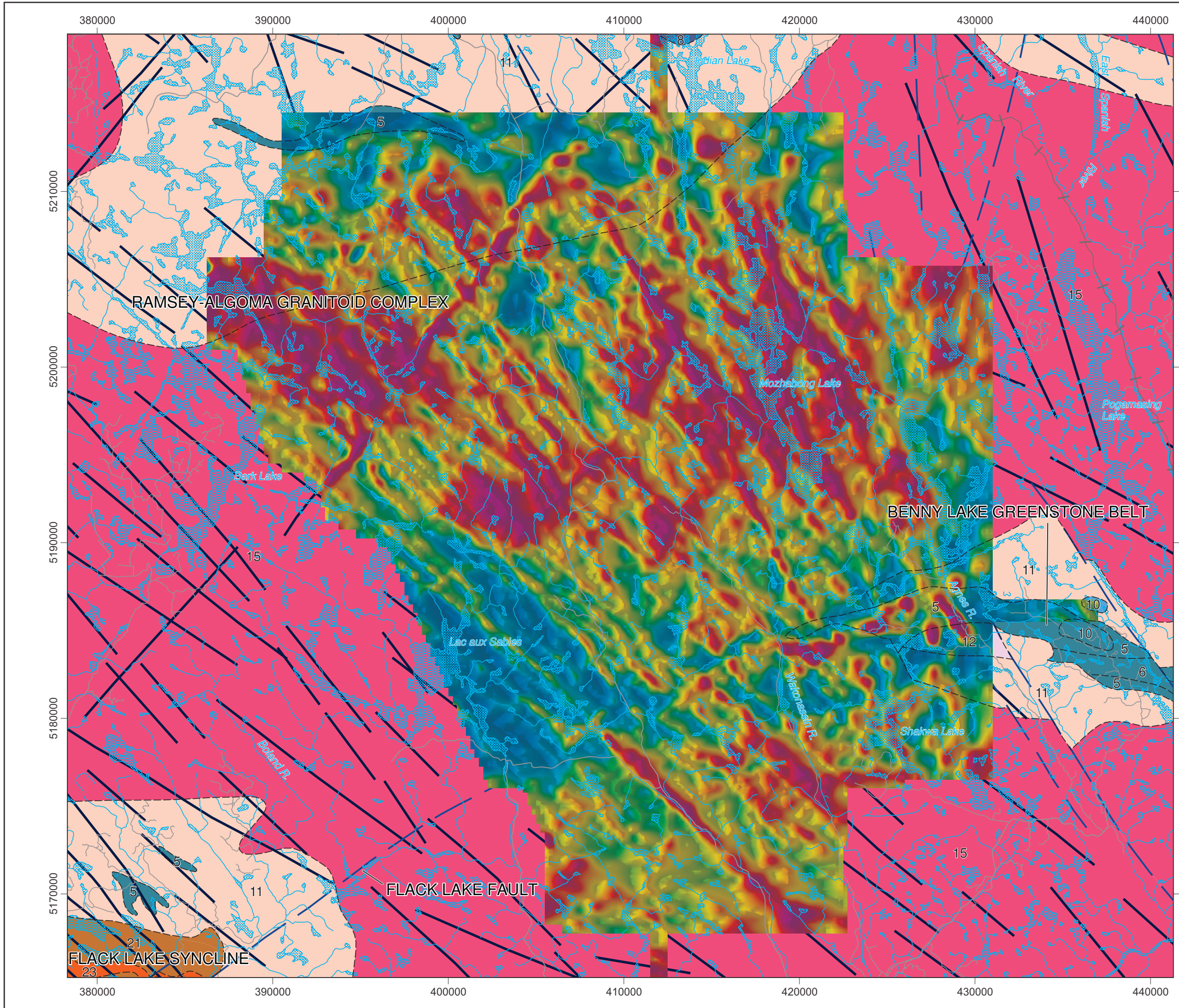


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**Reduction to the Pole
 of the Total Magnetic Intensity (25 m cell)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.7
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

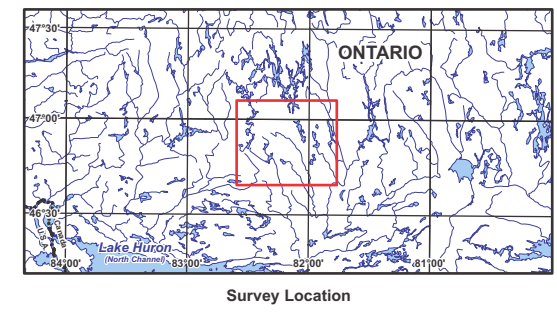
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

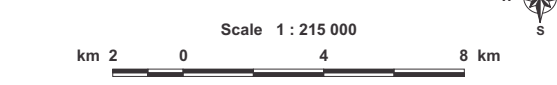
Map Parameters

Illumination: inclination 50°, declination 270°

nT



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

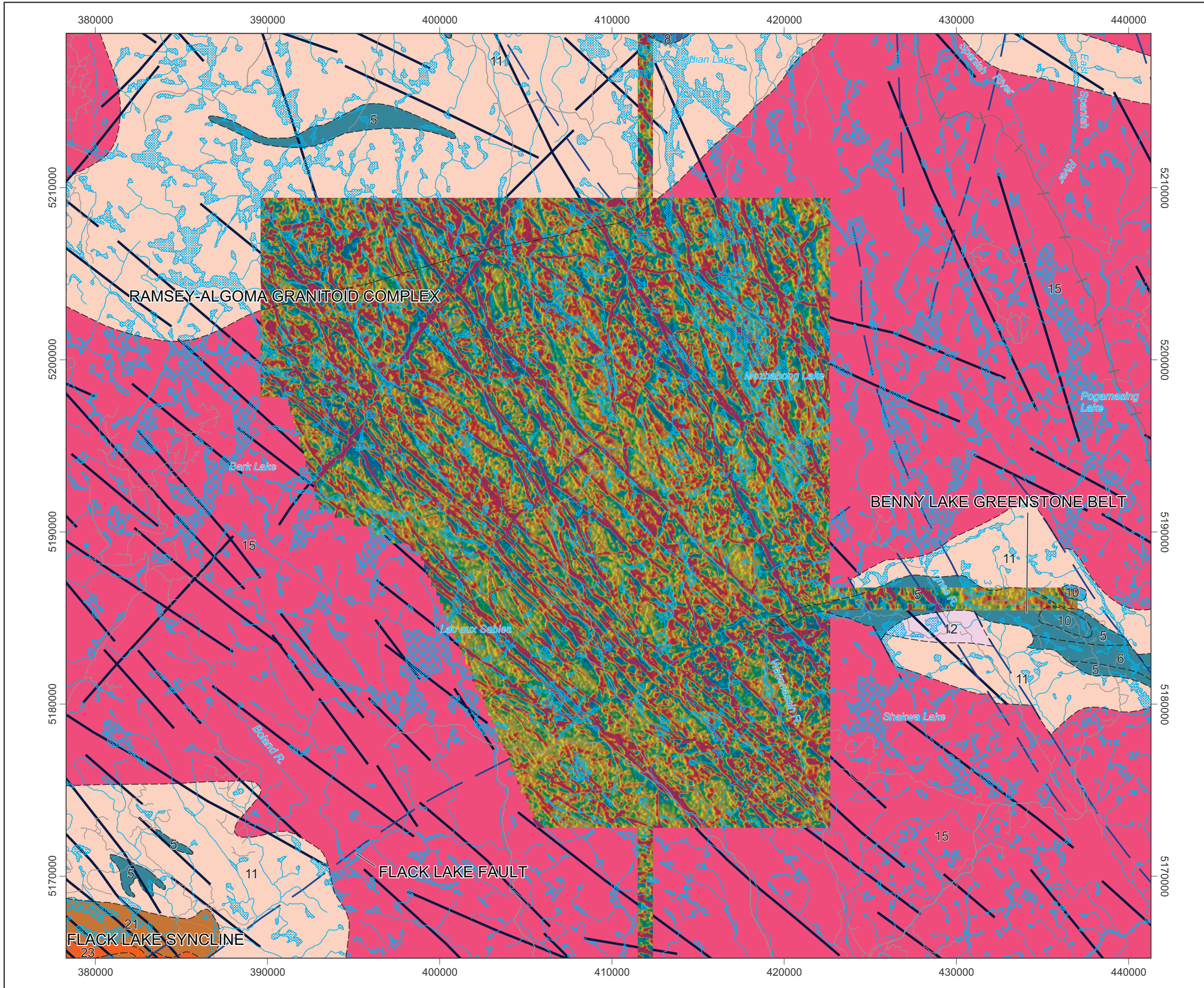


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**Reduction to the Pole
 of the Total Magnetic Intensity (250 m cell)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.8
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

- 37, 35, 30, 27, 23: Various rock units of the Southern Province
- 21, 20, 19, 18: Huronian Supergroup
- 17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

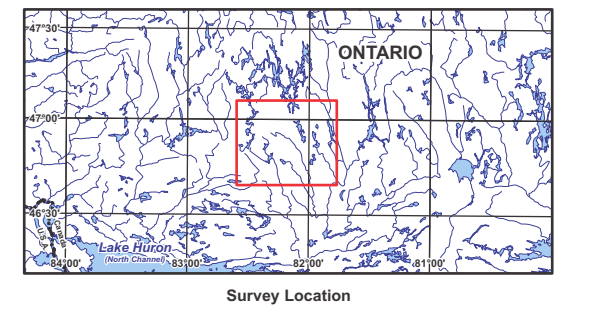
Archean

- 15: Massive granodiorite to granite
- 14, 12: Archean granatoid suites
- 11: Gneissic tonalite suites
- 10: Mafic and ultramafic rocks
- 8: Migmatized supracrustal rocks
- 7: Metasedimentary rocks
- 6, 5: Metavolcanic rocks

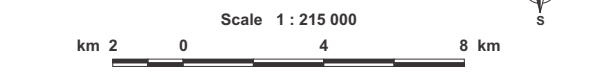
Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universal Transverse Mercator (UTM Zone 17N)

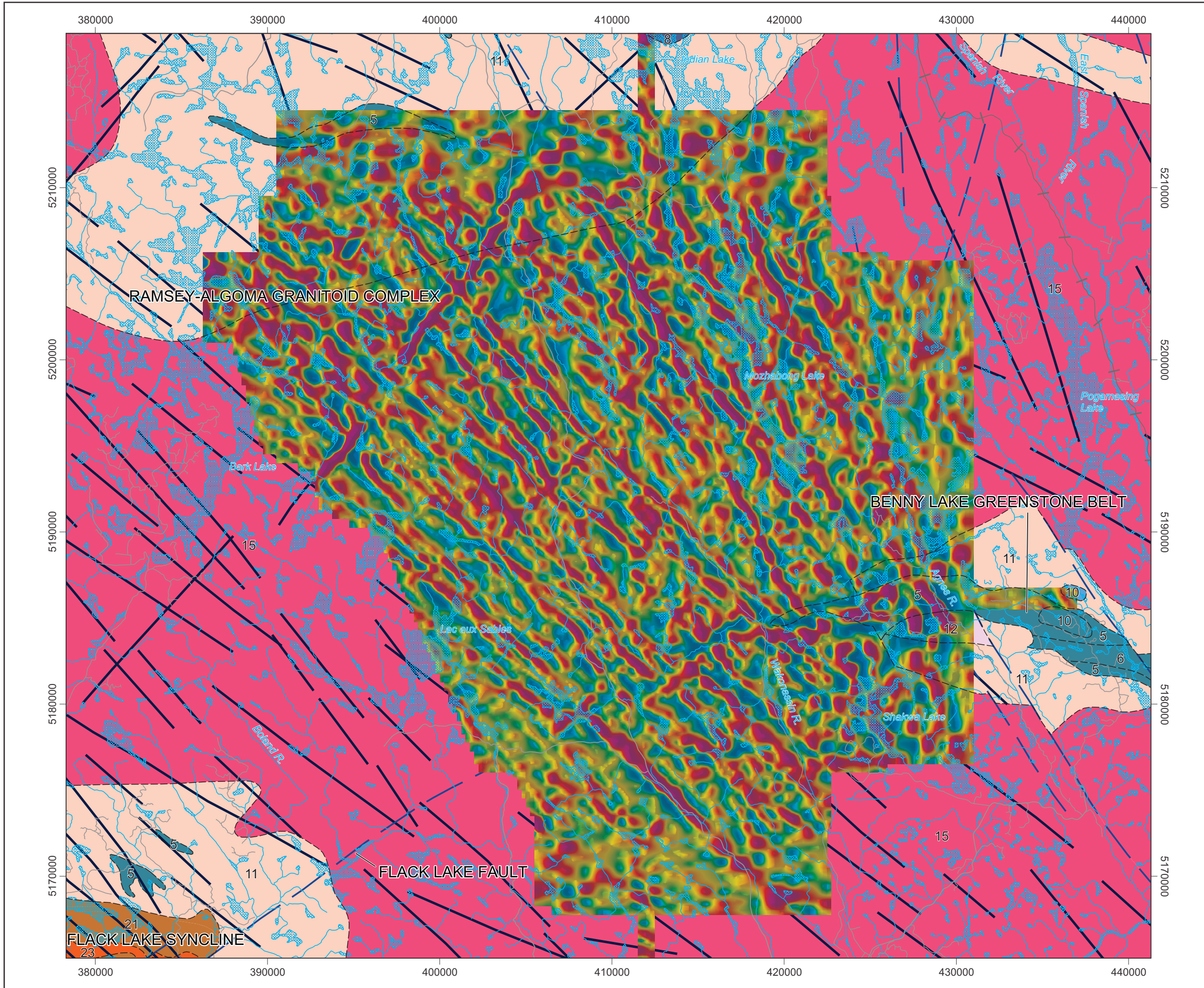


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

First Vertical Derivative of the
 Reduction to the Pole of the Total Magnetic Intensity
 (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.9
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

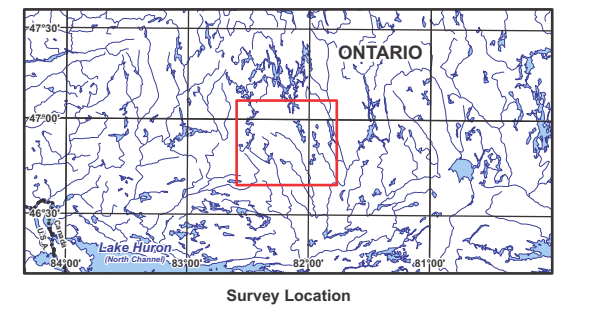
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

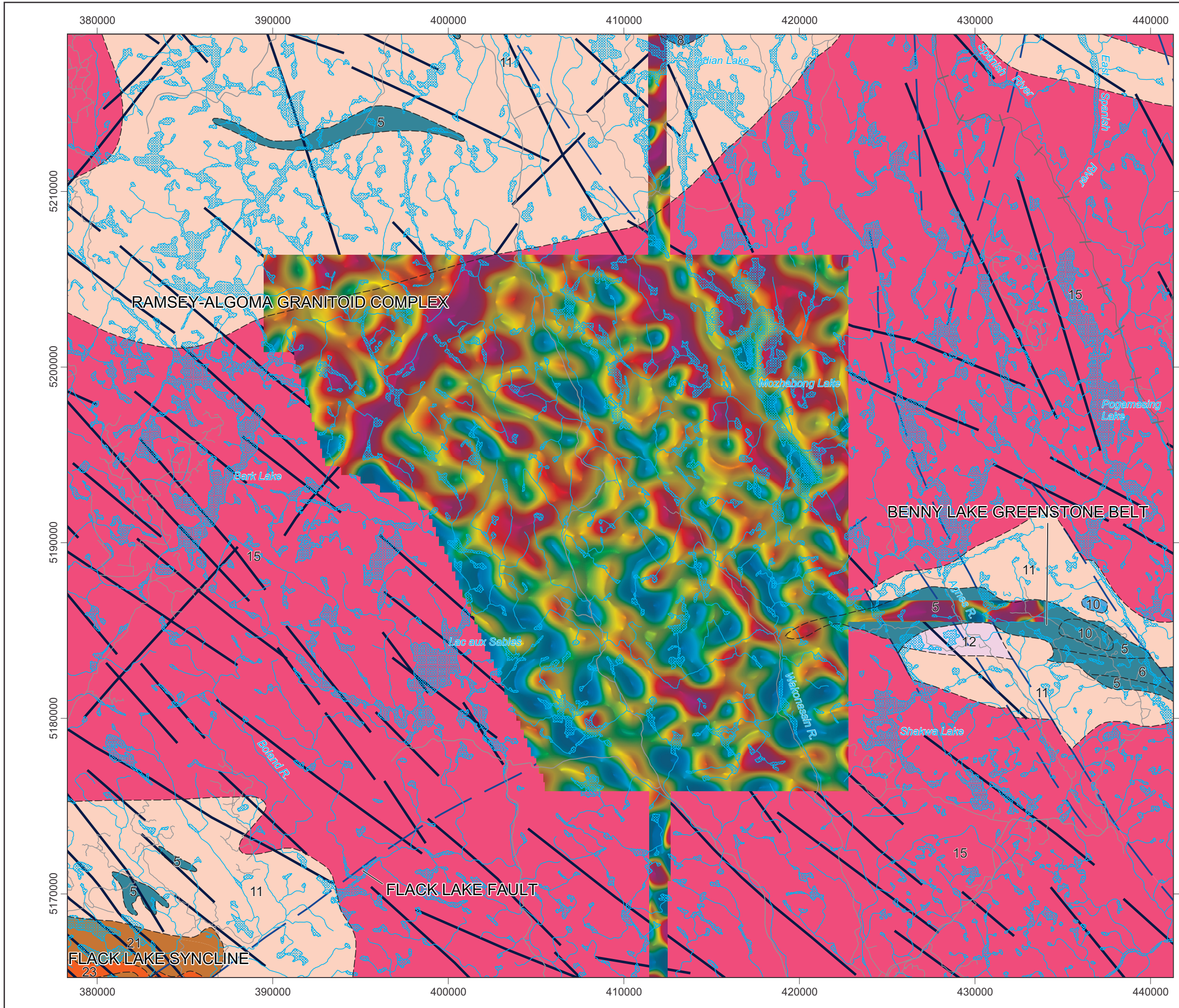


Airborne Geophysics
 Acquisition and Interpretation

Elliot Lake and Blind River Area, Ontario 2016

First Vertical Derivative of the
 Reduction to the Pole of the Total Magnetic Intensity
 (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.10
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

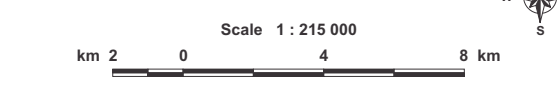
Spatial Filter (half-wavelength): 1000 m

Bouguer Density: 2.67 g/cm³

Eötvös

Survey Location

BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



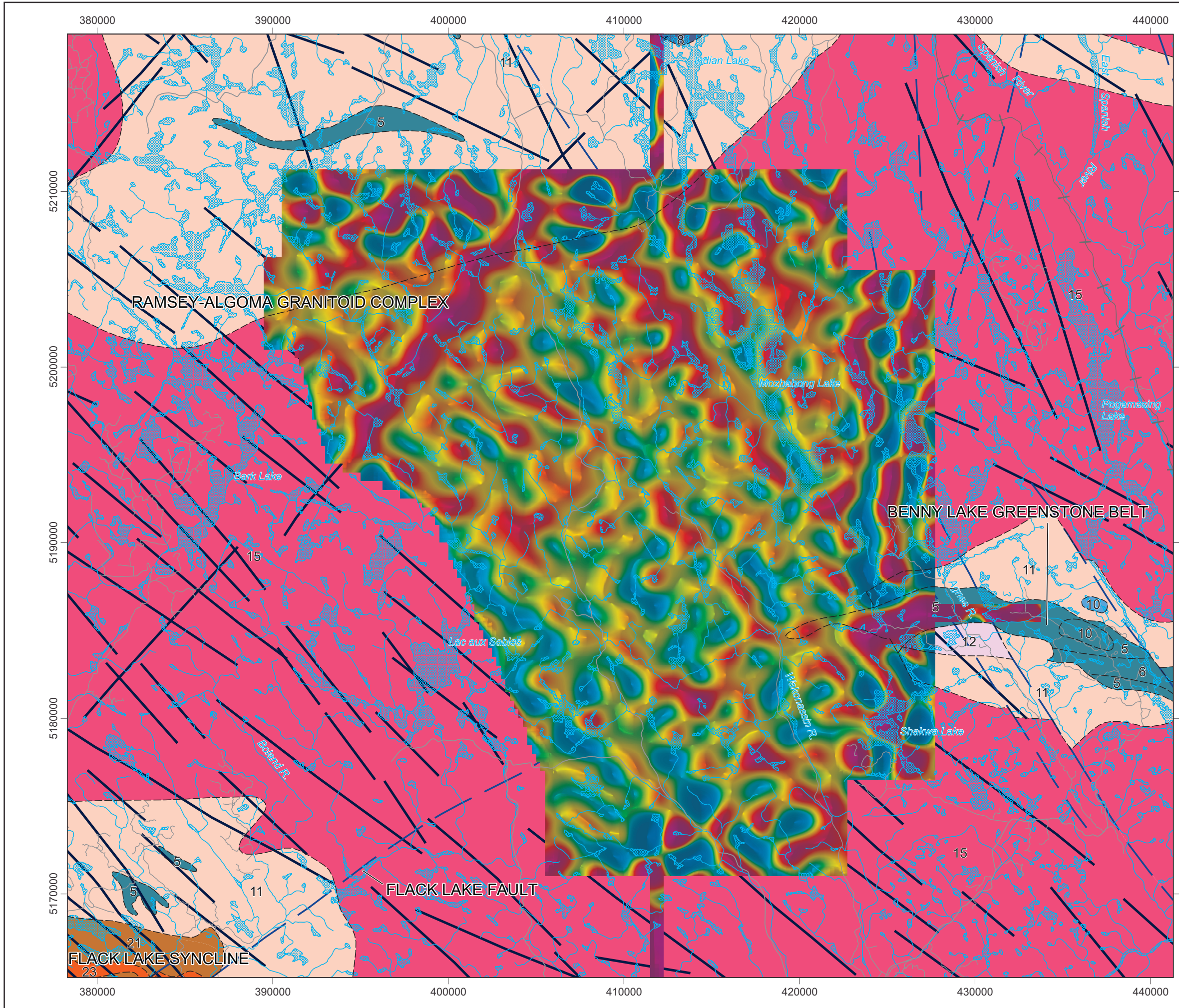
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**First Vertical Derivative
 of the Bouguer Gravity
 (Density: 2.67 g/cm³) (25 m cell)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.11



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

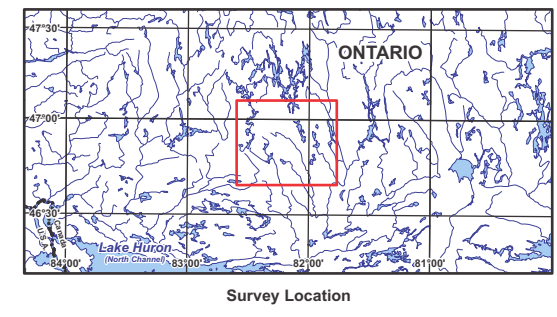
Map Parameters

Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

Bouguer Density: 2.67 g/cm³

Eötvös



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



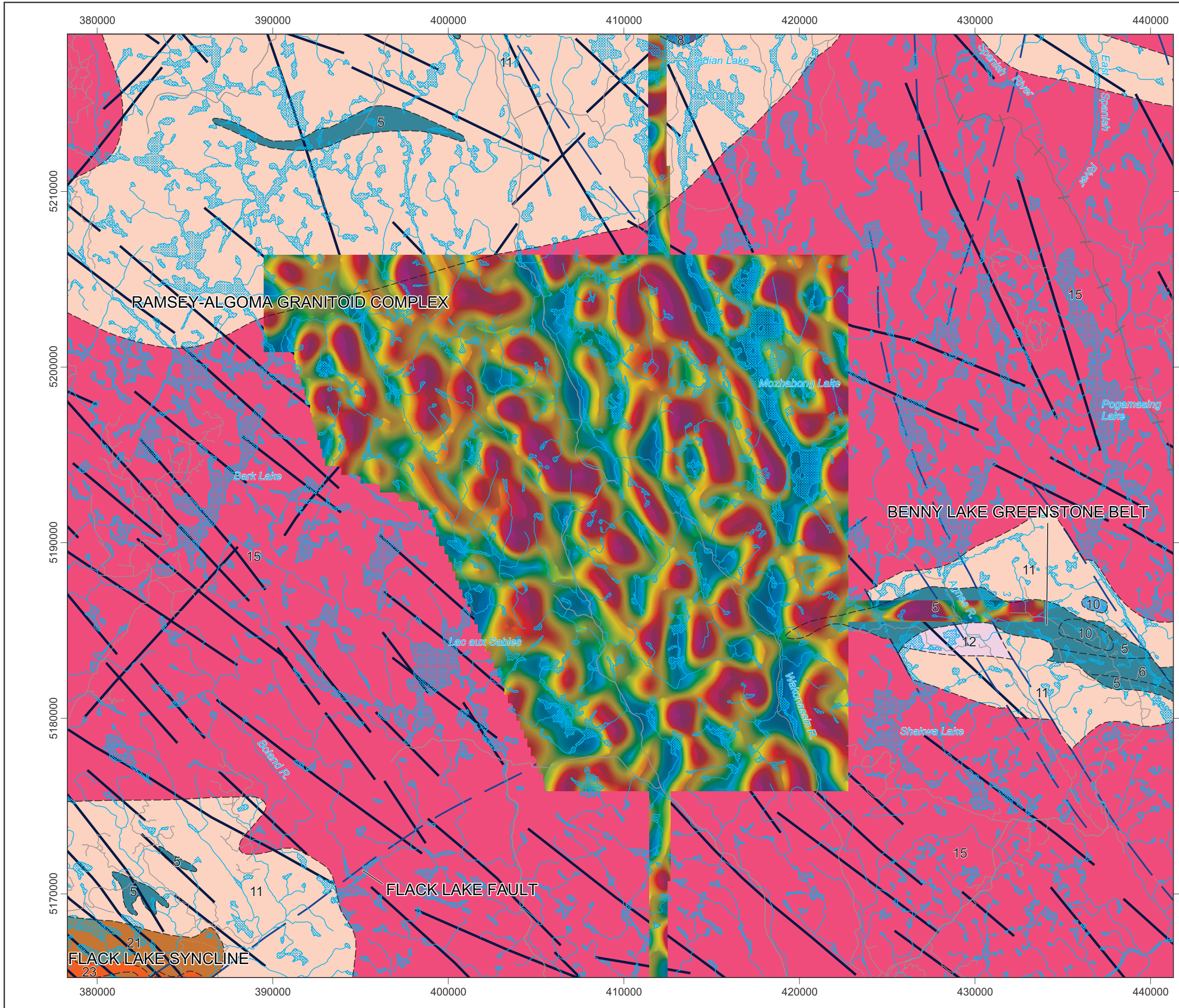
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**First Vertical Derivative
 of the Bouguer Gravity
 (Density: 2.67g/ cm³) (250 m cell)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.12



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

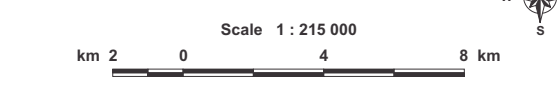
Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

Eötvös

Survey Location

BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



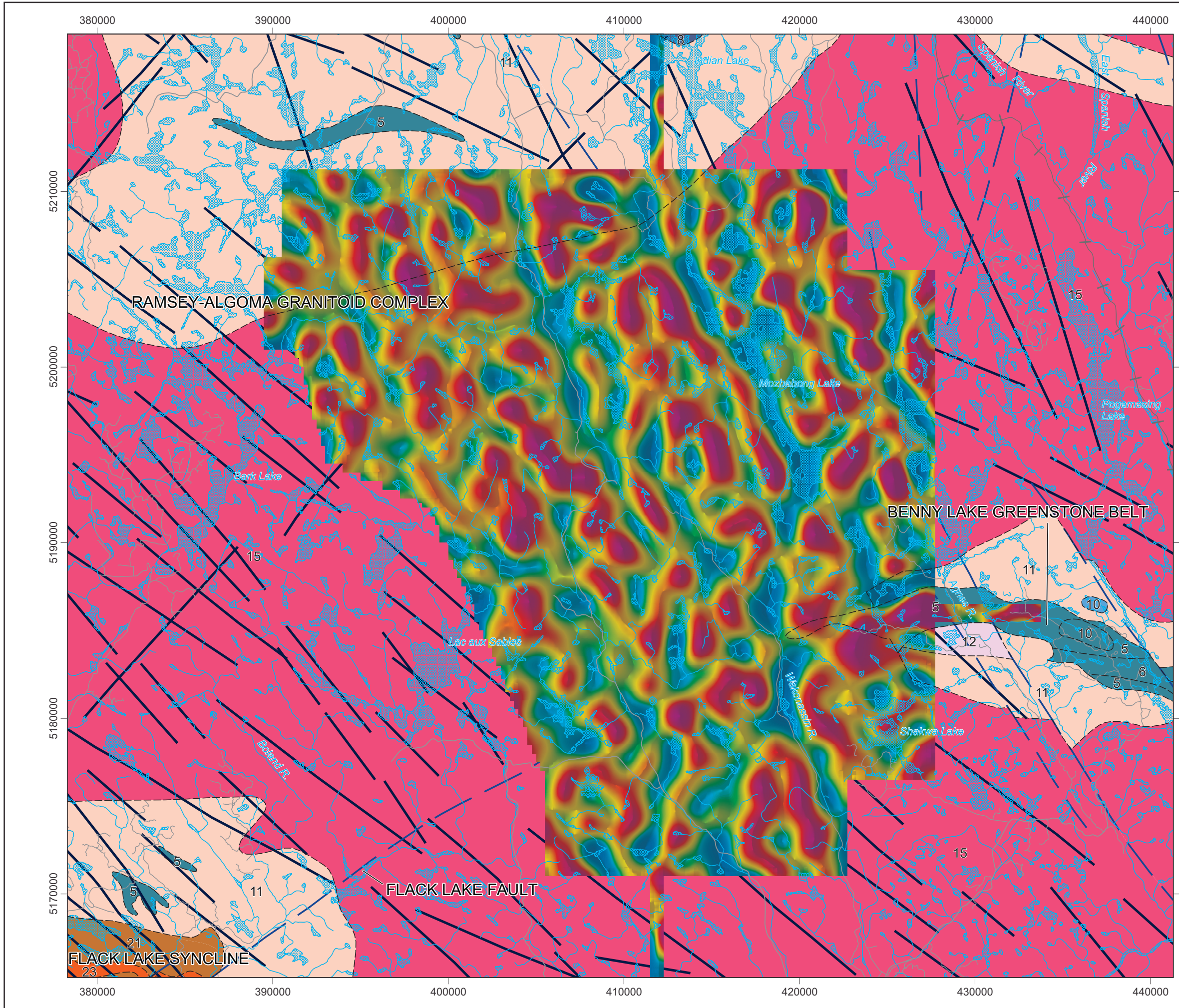
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

First Vertical Derivative of the Free Air Gravity
 (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.13



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

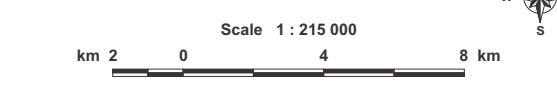
Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

Eötvös

Survey Location

BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



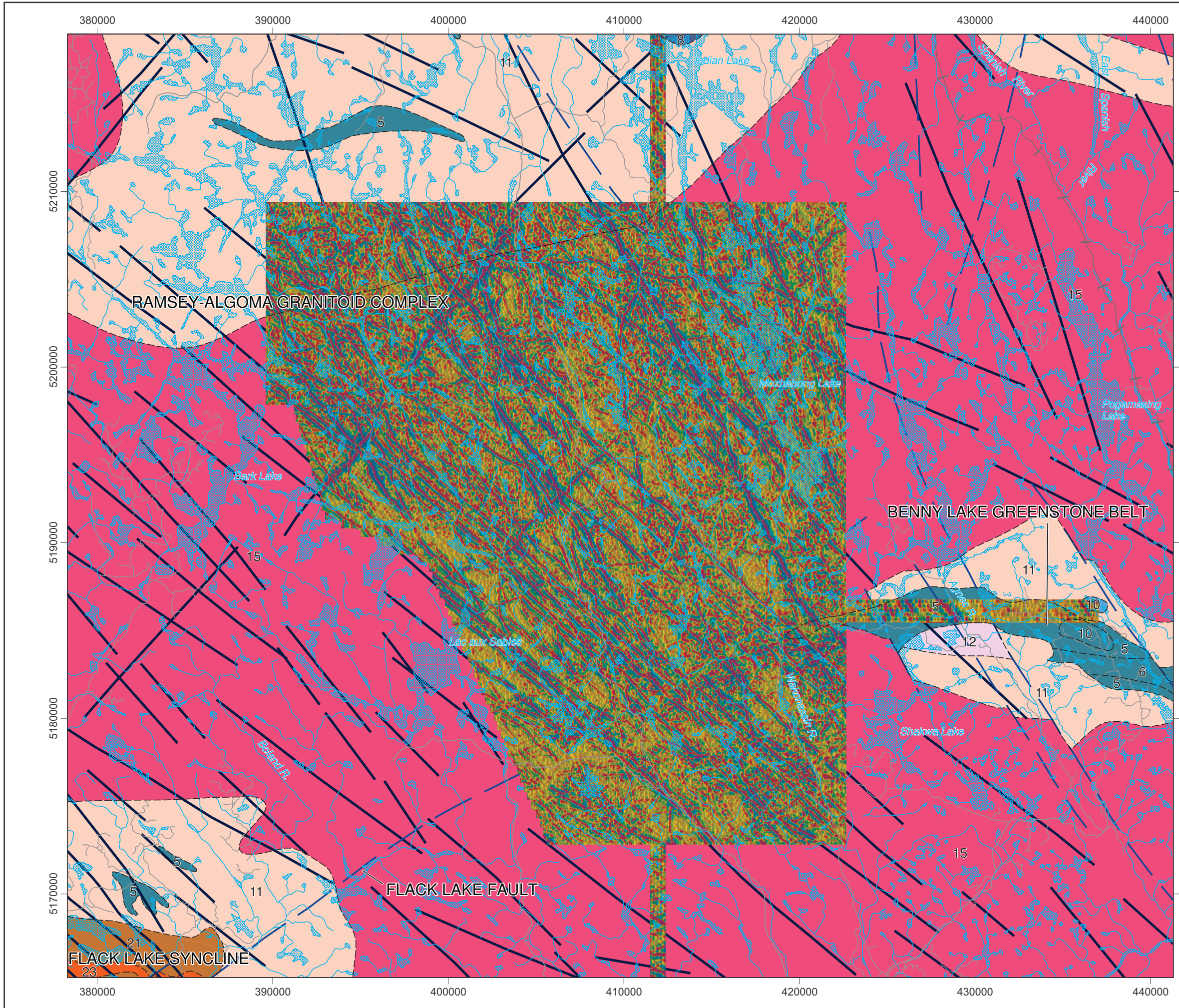
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

First Vertical Derivative of the Free Air Gravity
 (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.14



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

- 37, 35, 30, 27, 23: Various rock units of the Southern Province
- 21, 20, 19, 18: Huronian Supergroup
- 17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

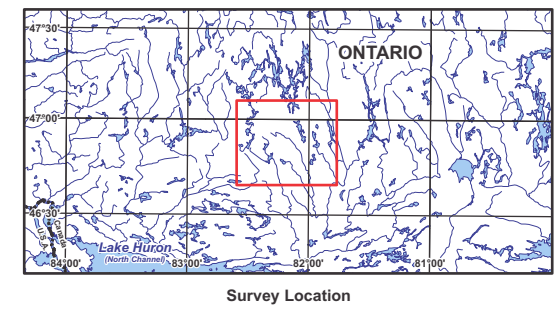
Archean

- 15: Massive granodiorite to granite
- 14, 12: Archean granatoid suites
- 11: Gneissic tonalite suites
- 10: Mafic and ultramafic rocks
- 8: Migmatized supracrustal rocks
- 7: Metasedimentary rocks
- 6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km²



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

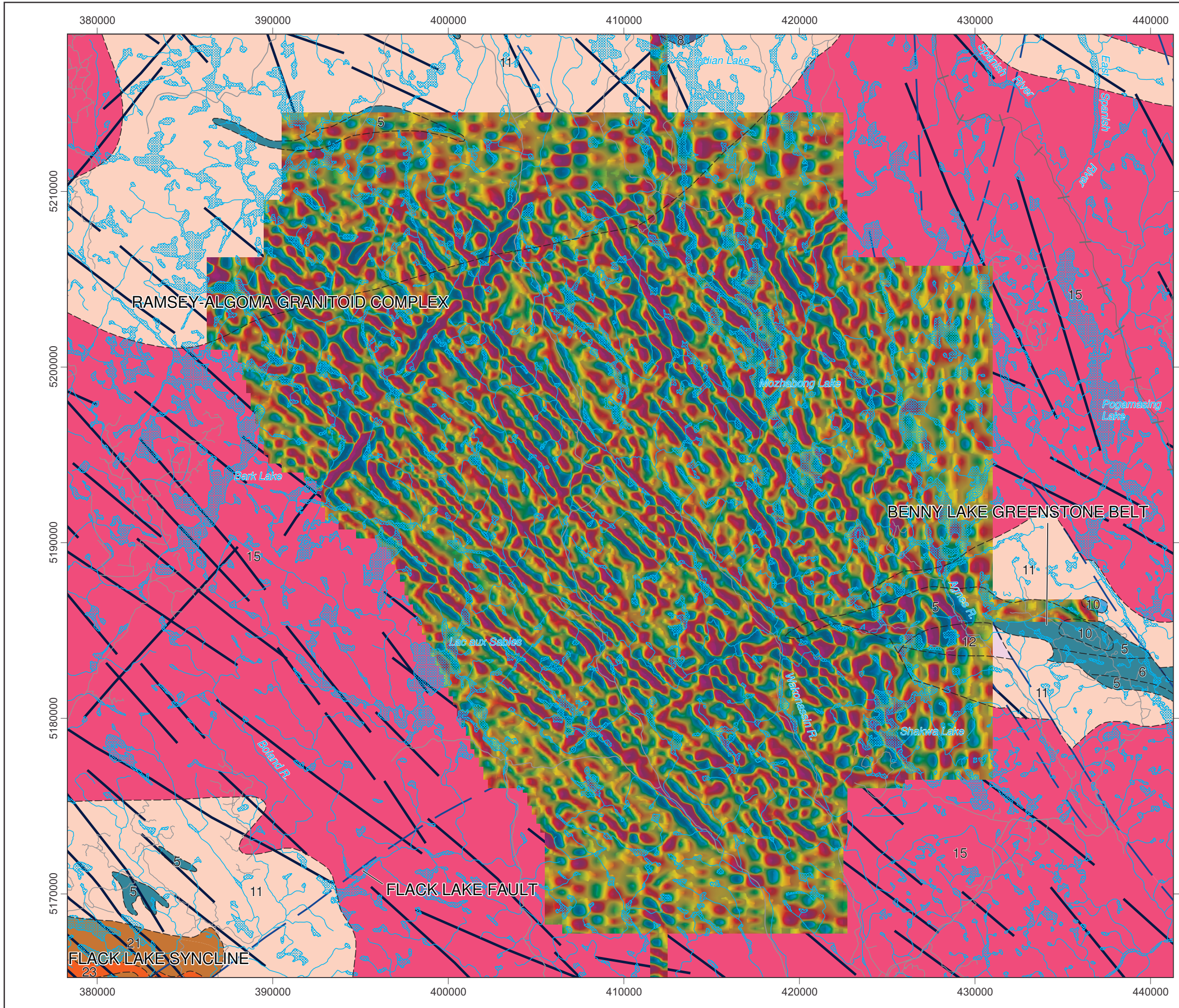


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Second Vertical Derivative of the
 Reduction to the Pole of the Total Magnetic Intensity
 (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.15
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

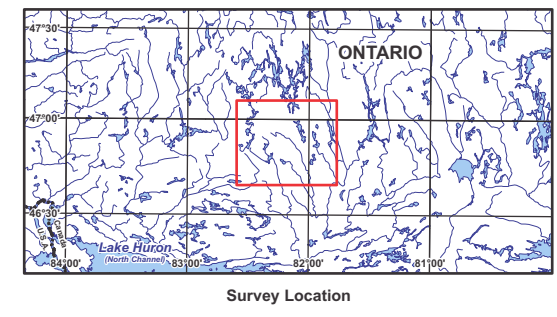
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km²



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

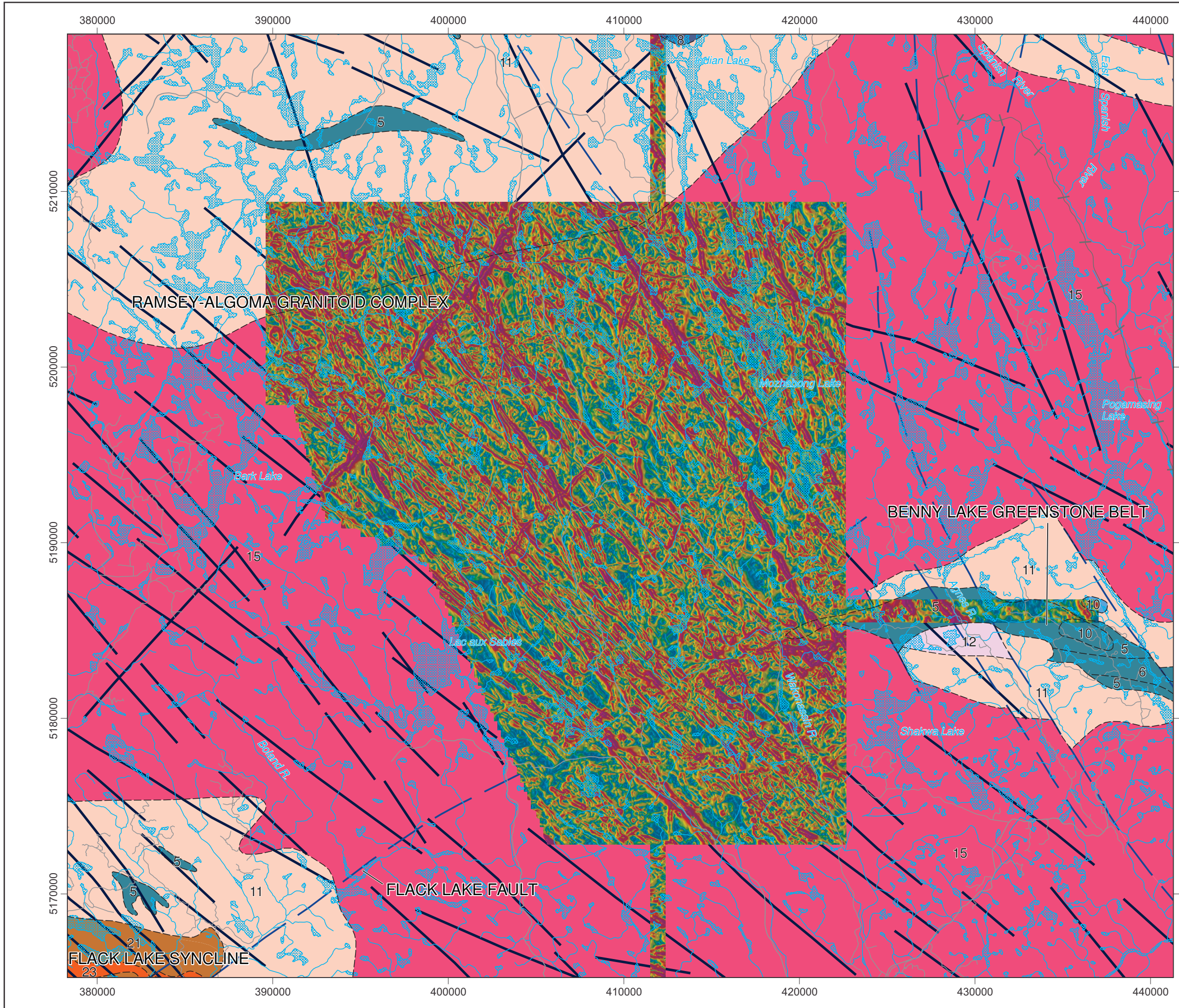


Airborne Geophysics
 Acquisition and Interpretation

Elliot Lake and Blind River Area, Ontario 2016

Second Vertical Derivative of the
 Reduction to the Pole of the Total Magnetic Intensity
 (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.16
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

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15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

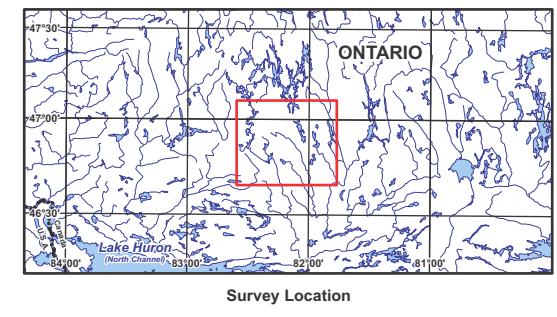
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



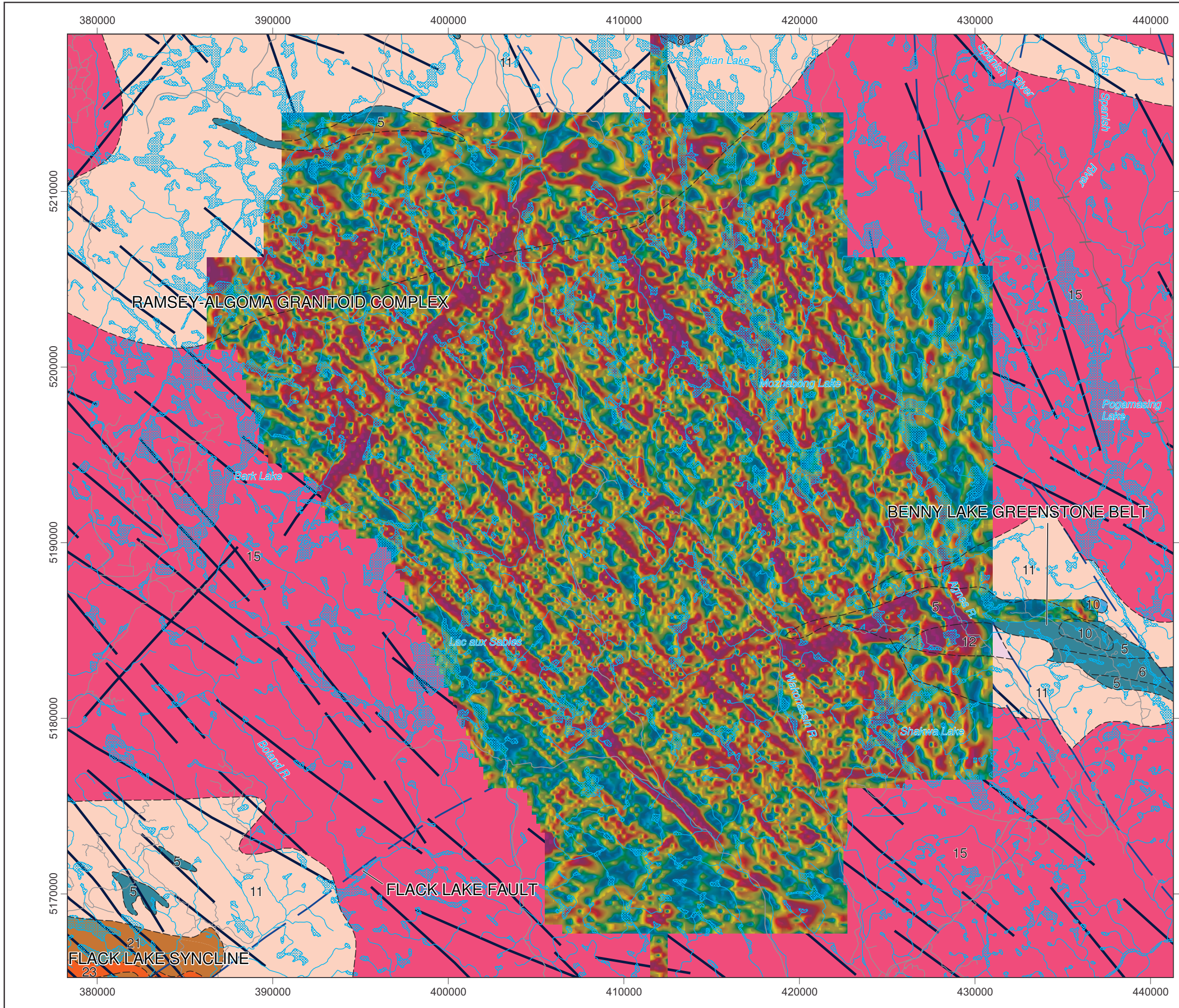
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the
 Reduction to the Pole of the Total Magnetic Intensity
 (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.17



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

- 37, 35, 30, 27, 23: Various rock units of the Southern Province
- 21, 20, 19, 18: Huronian Supergroup
- 17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

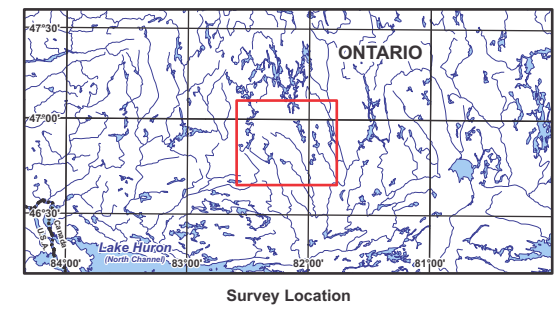
Archean

- 15: Massive granodiorite to granite
- 14, 12: Archean granatoid suites
- 11: Gneissic tonalite suites
- 10: Mafic and ultramafic rocks
- 8: Migmatized supracrustal rocks
- 7: Metasedimentary rocks
- 6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

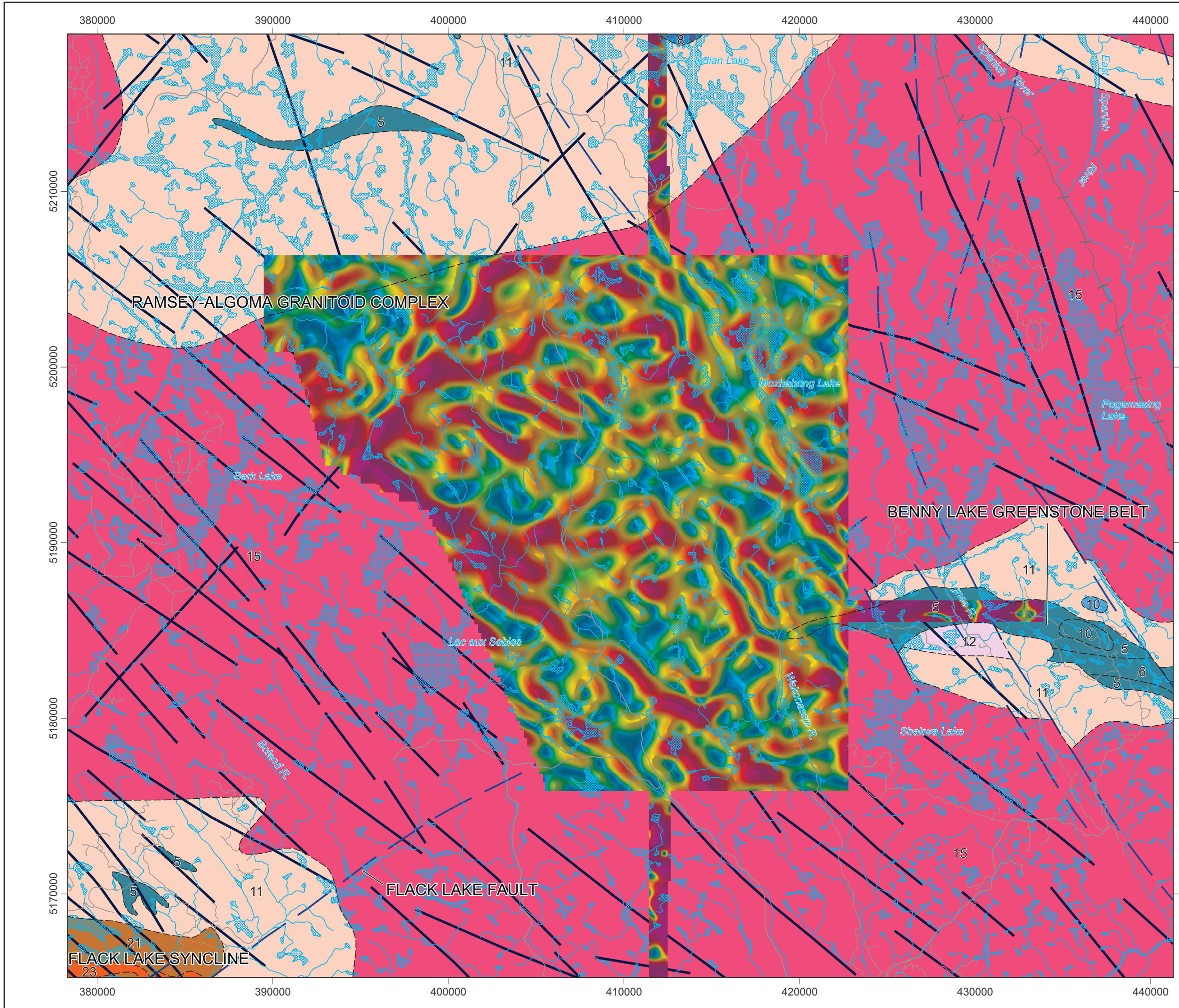


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the
 Reduction to the Pole of the Total Magnetic Intensity
 (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.18
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

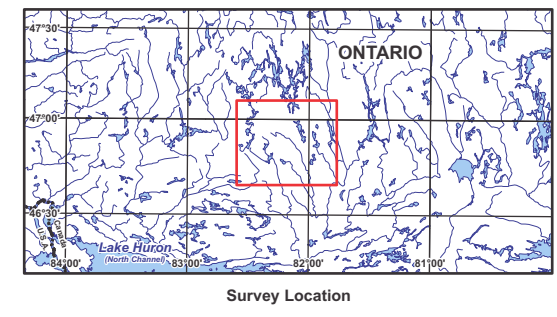
Map Parameters

Illumination: inclination 50°, declination 270°

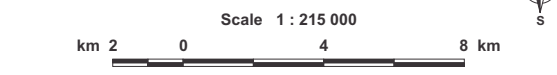
Spatial Filter (half-wavelength): 1000 m

Bouguer Density: 2.67 g/cm³

mGal/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

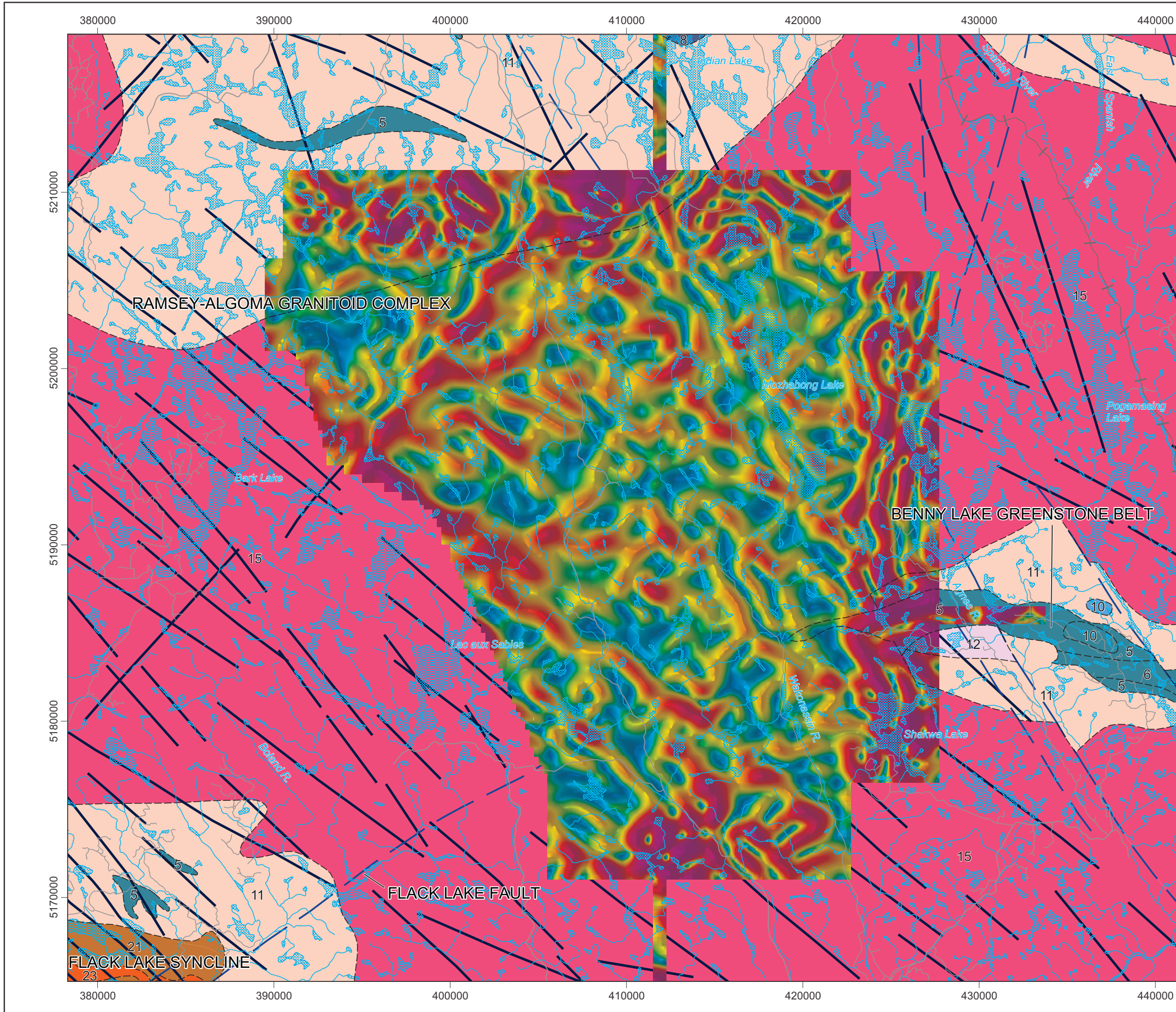


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the Bouguer Gravity
 (Density: 2.67g/cm³) (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.19
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

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11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

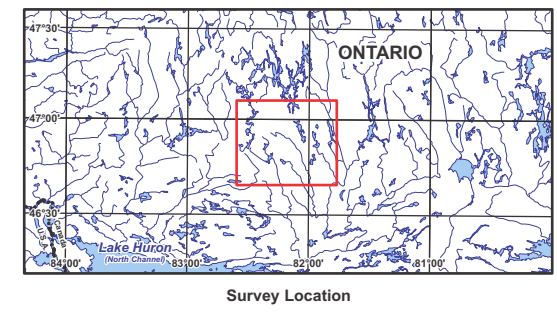
Map Parameters

Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

Bouguer Density: 2.67 g/cm³

mGal/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



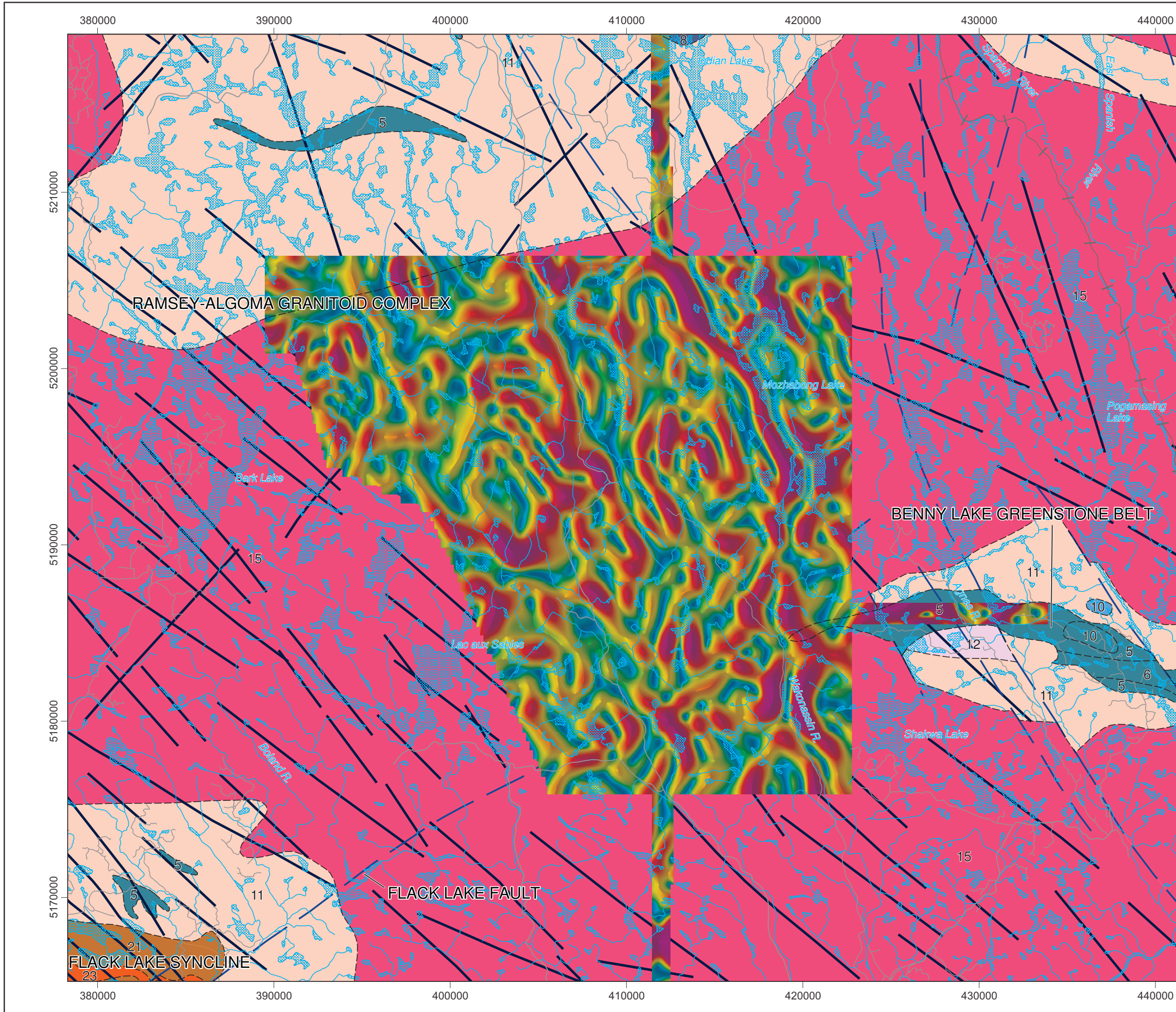
Airborne Geophysics
 Acquisition and Interpretation

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the Bouguer Gravity
 (Density: 2.67g/cm³) (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.20



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

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8: Migmatized supracrustal rocks

7: Metasedimentary rocks

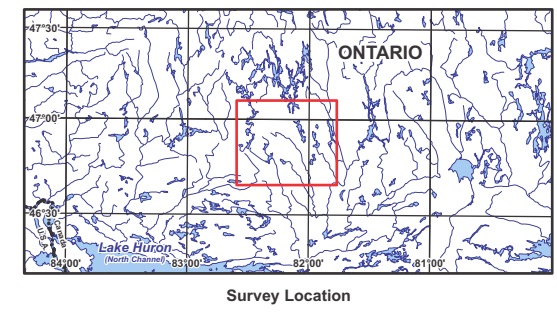
6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

mGal/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

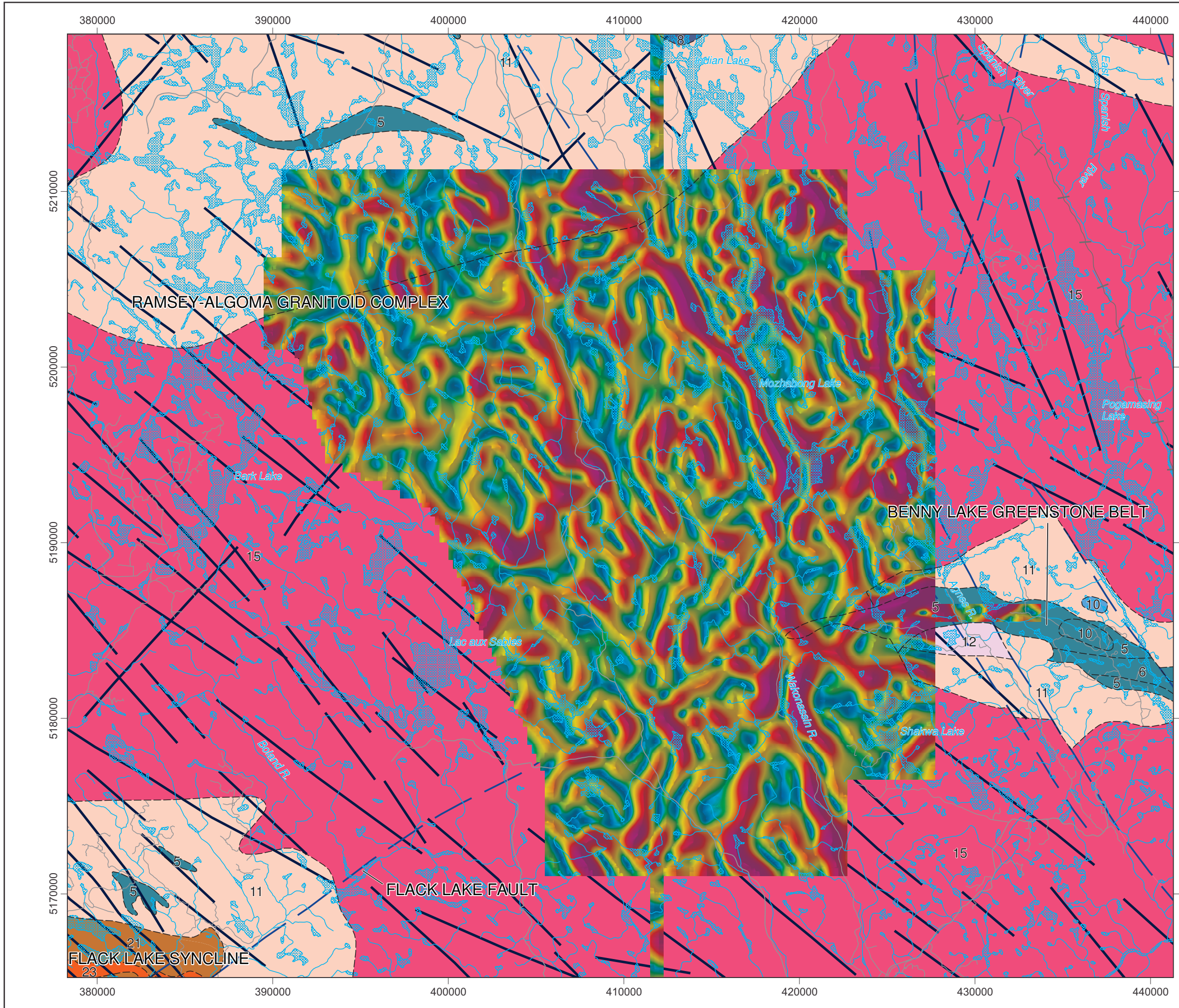


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the Free Air Gravity
 (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.21
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

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8: Migmatized supracrustal rocks

7: Metasedimentary rocks

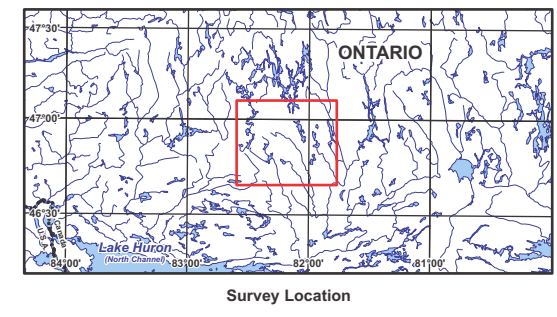
6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

mGal/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

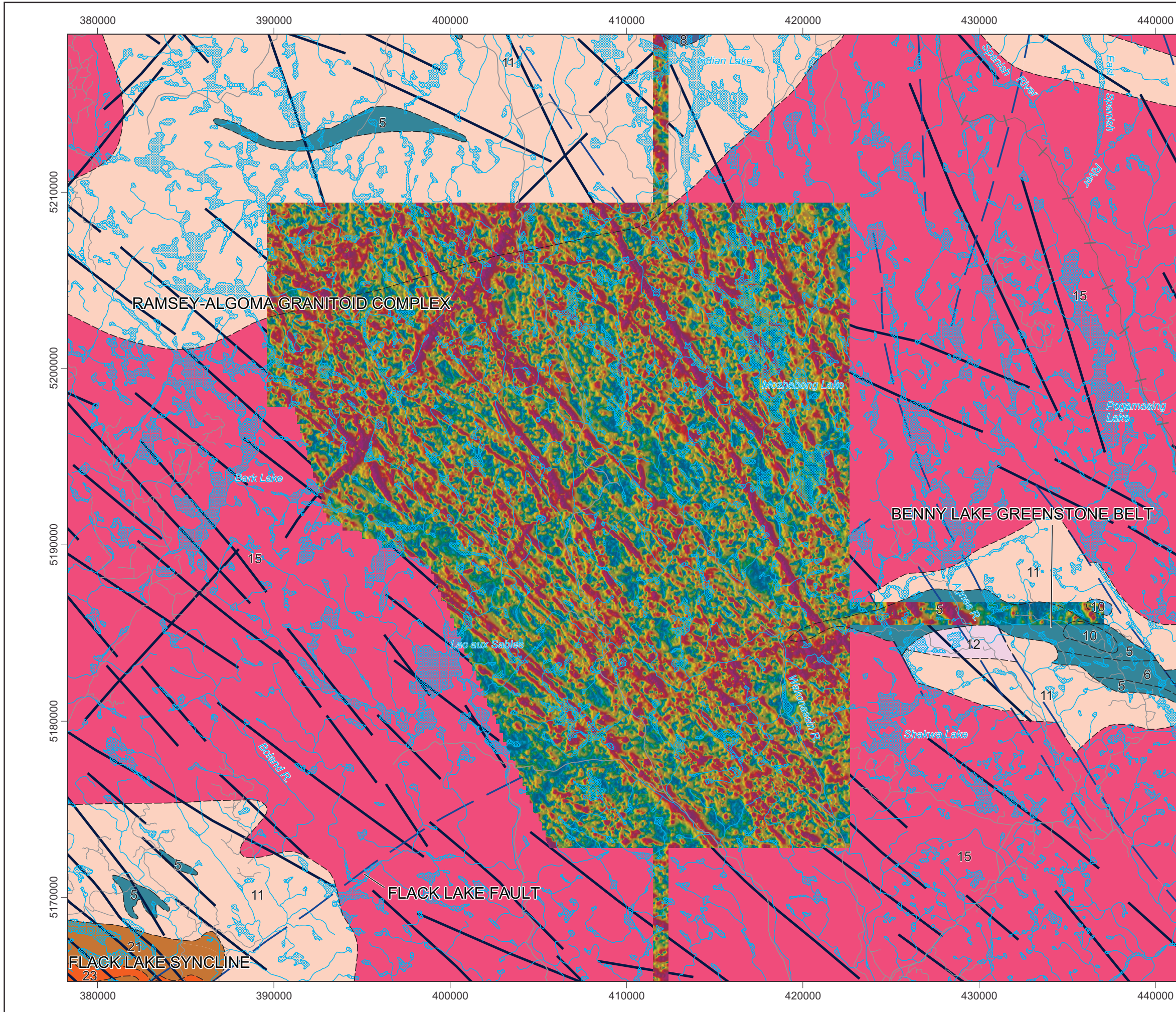


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the Free Air Gravity
 (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 4.22
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

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8: Migmatized supracrustal rocks

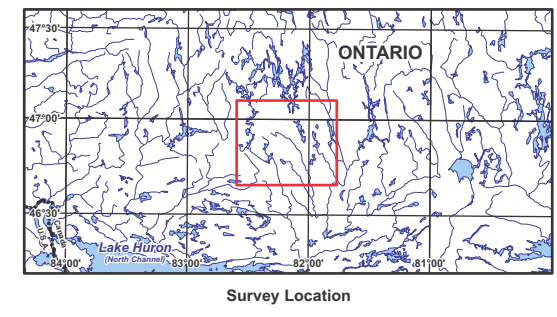
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



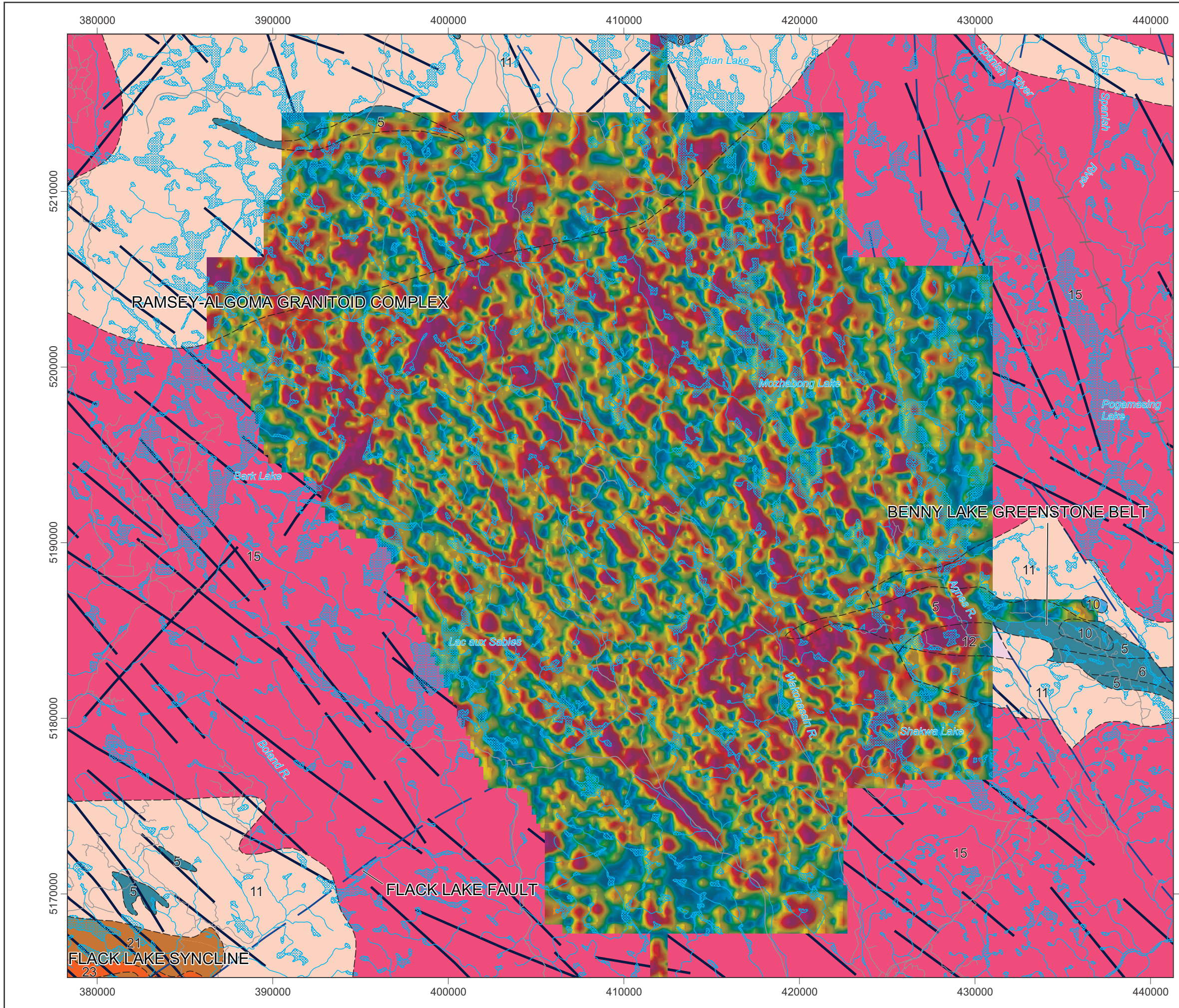
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**Total Gradient Amplitude
 of the Total Magnetic Intensity
 (25 m cell)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.23



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

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8: Migmatized supracrustal rocks

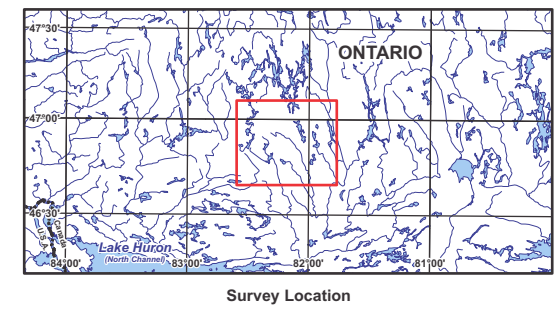
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



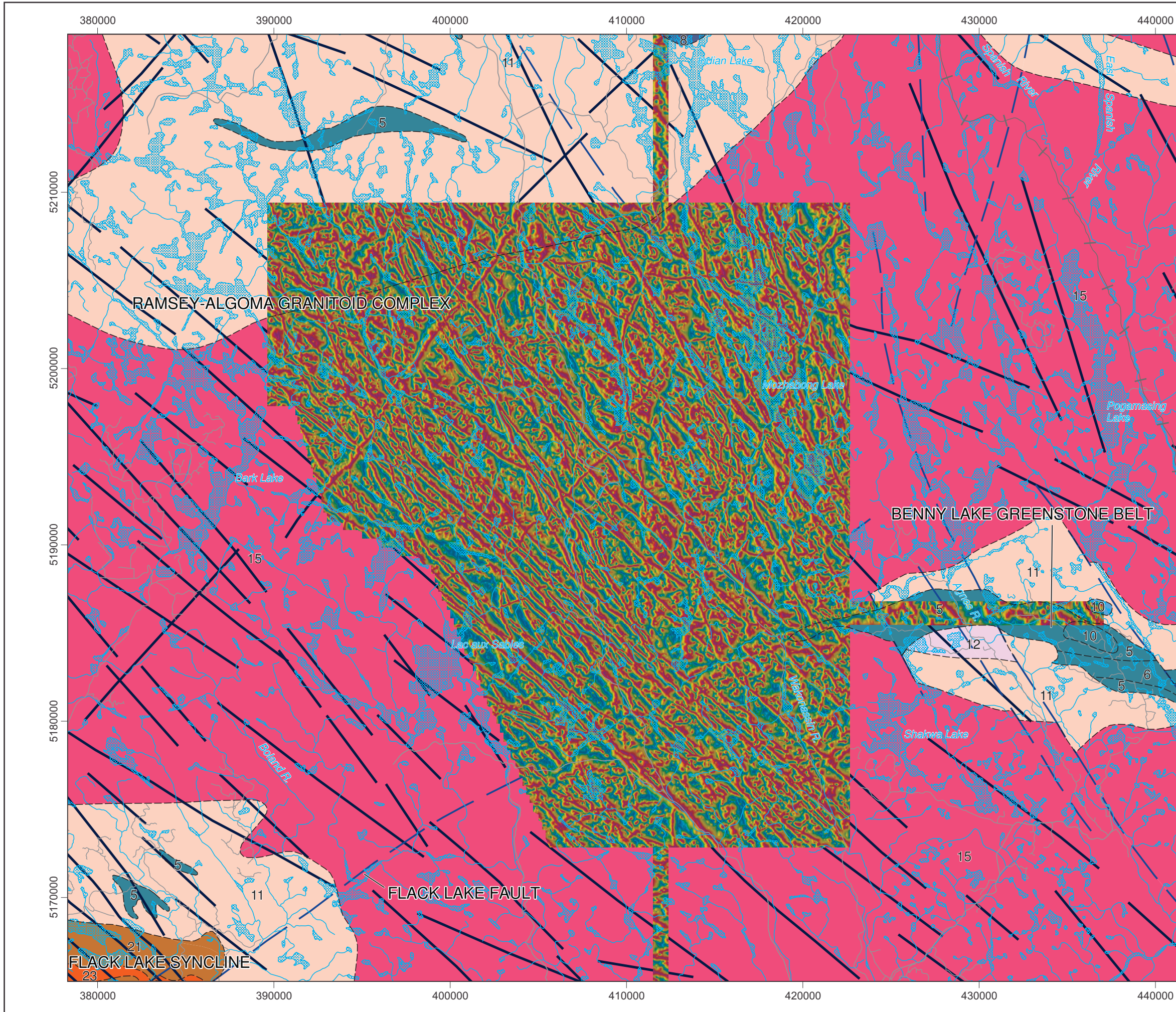
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**Total Gradient Amplitude
 of the Total Magnetic Intensity
 (250 m cell)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.24



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

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17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

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8: Migmatized supracrustal rocks

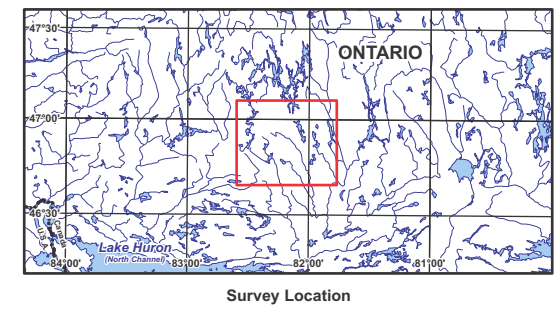
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

degrees



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



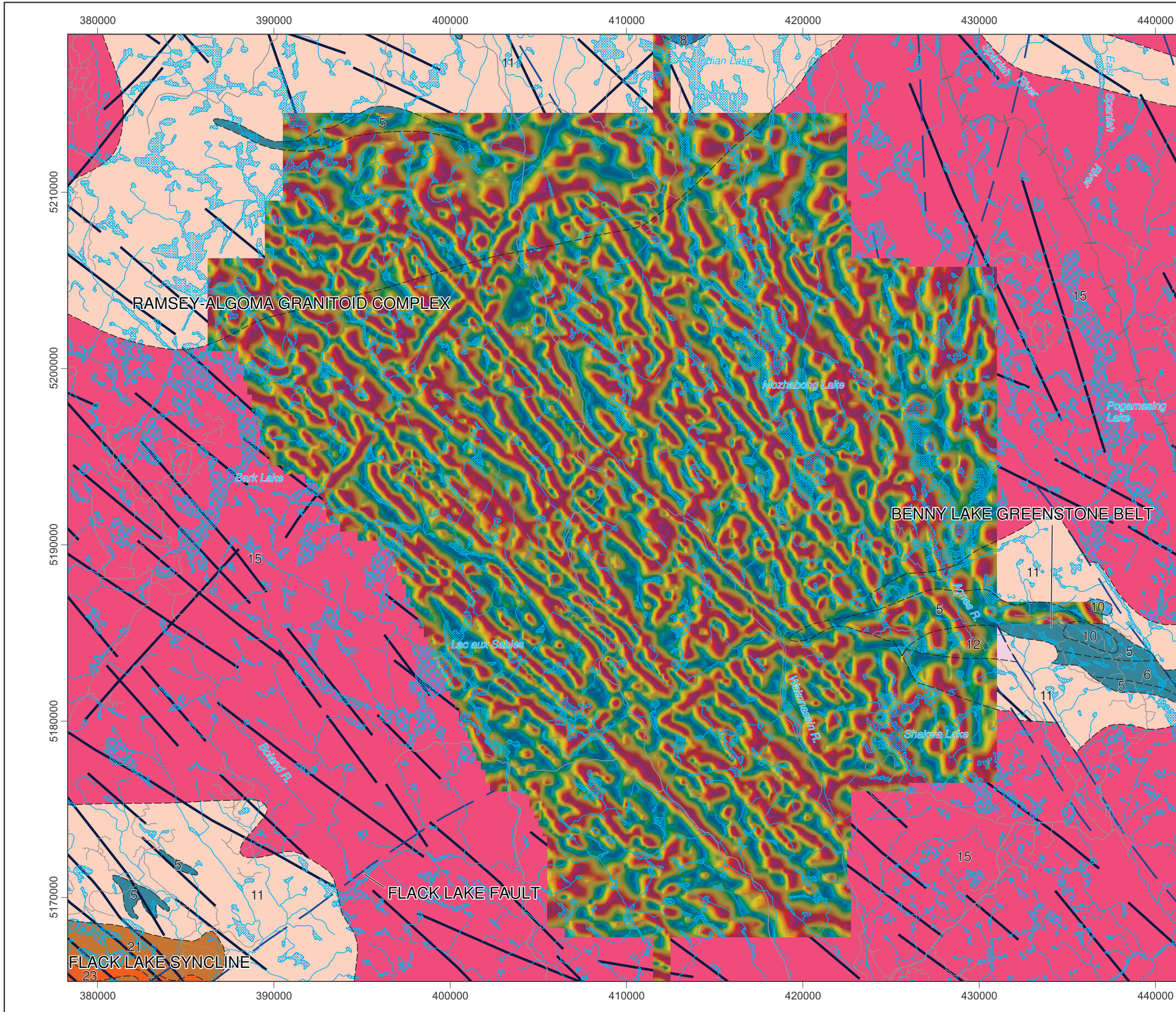
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Tilt Angle of the Reduction to the Pole
 of the Total Magnetic Intensity
 (25 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.25



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

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11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

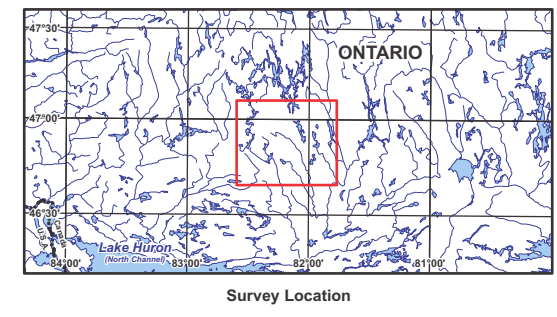
7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Map Parameters

Illumination: inclination 50°, declination 270°

degrees



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



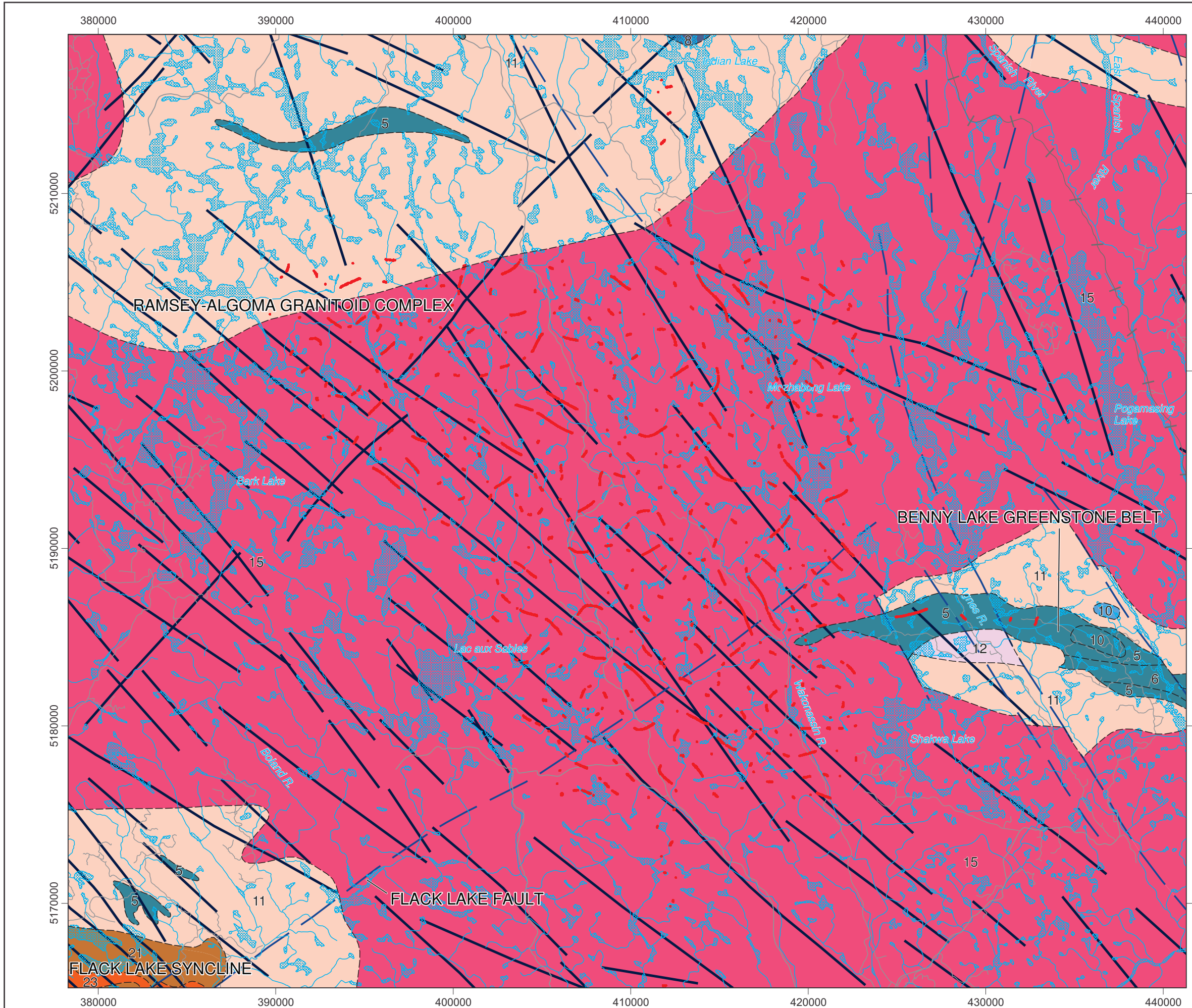
**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Tilt Angle of the Reduction to the Pole
 of the Total Magnetic Intensity
 (250 m cell)

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.26



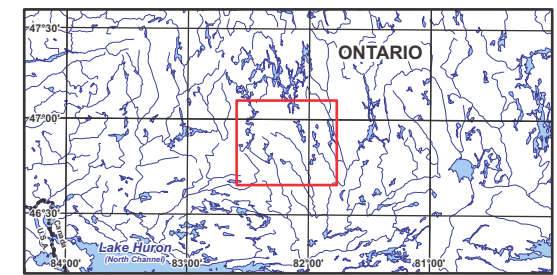
- Legend**
- Hydrography
 - Roads
 - Railway
 - Powerline
 - Pipeline

- Geology**
- Fault
 - Dyke

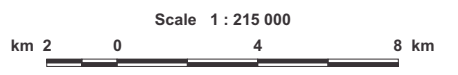
- Proterozoic**
- 37, 35, 30, 27, 23: Various rock units of the Southern Province
 - 21, 20, 19, 18: Huronian Supergroup
 - 17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

- Archean**
- 15: Massive granodiorite to granite
 - 14, 12: Archean granatoid suites
 - 11: Gneissic tonalite suites
 - 10: Mafic and ultramafic rocks
 - 8: Migmatized supracrustal rocks
 - 7: Metasedimentary rocks
 - 6, 5: Metavolcanic rocks

- Trend Analysis Solutions**
- Depth below surface
- 0 - 100 m
 - 101 - 200 m
 - > 200 m



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)



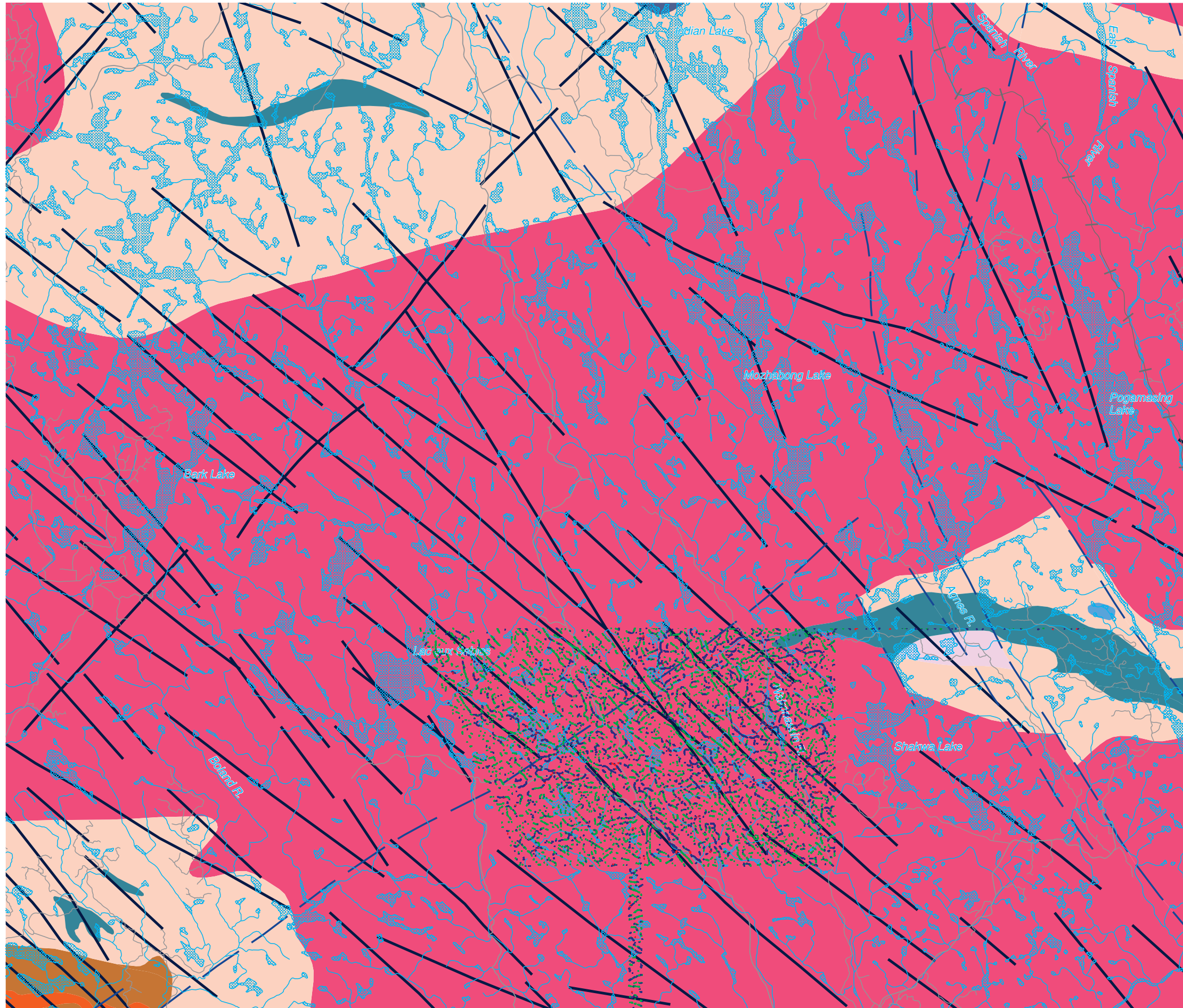
**Airborne Geophysics
 Acquisition and Interpretation**

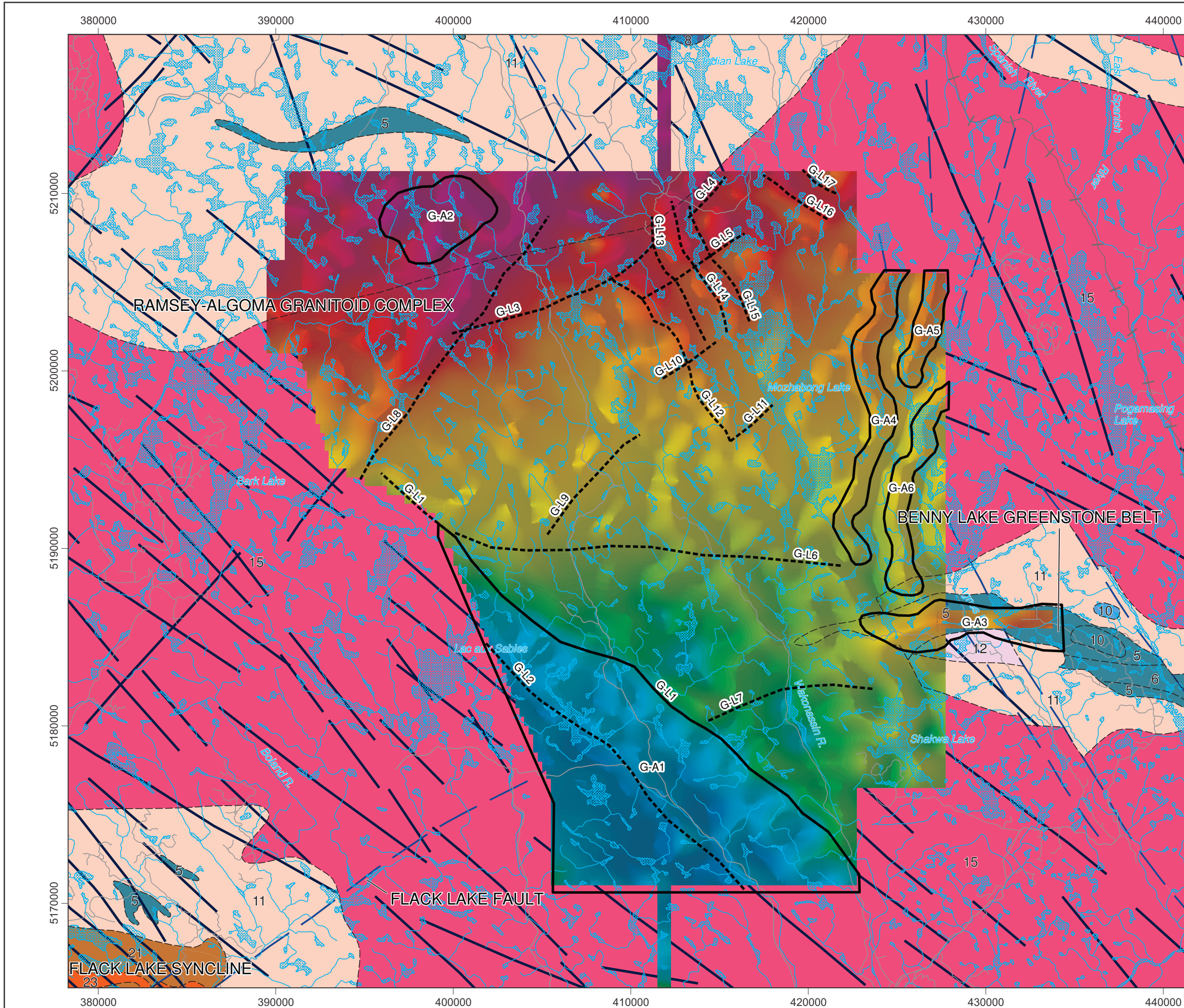
Elliot Lake and Blind River Area, Ontario 2016

**Trend Analysis Solutions of Bouguer Gravity
 (terrain correction density = 2.67 g/cm³)**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	

FIGURE: 4.27





Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

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8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Gravity Anomaly

Gravity Lineament

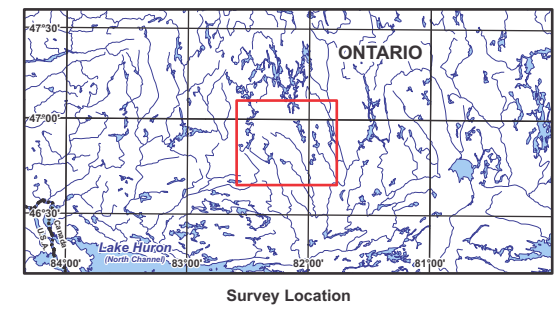
Map Parameters

Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

Bouguer Density: 2.67 g/cm³

mGal



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

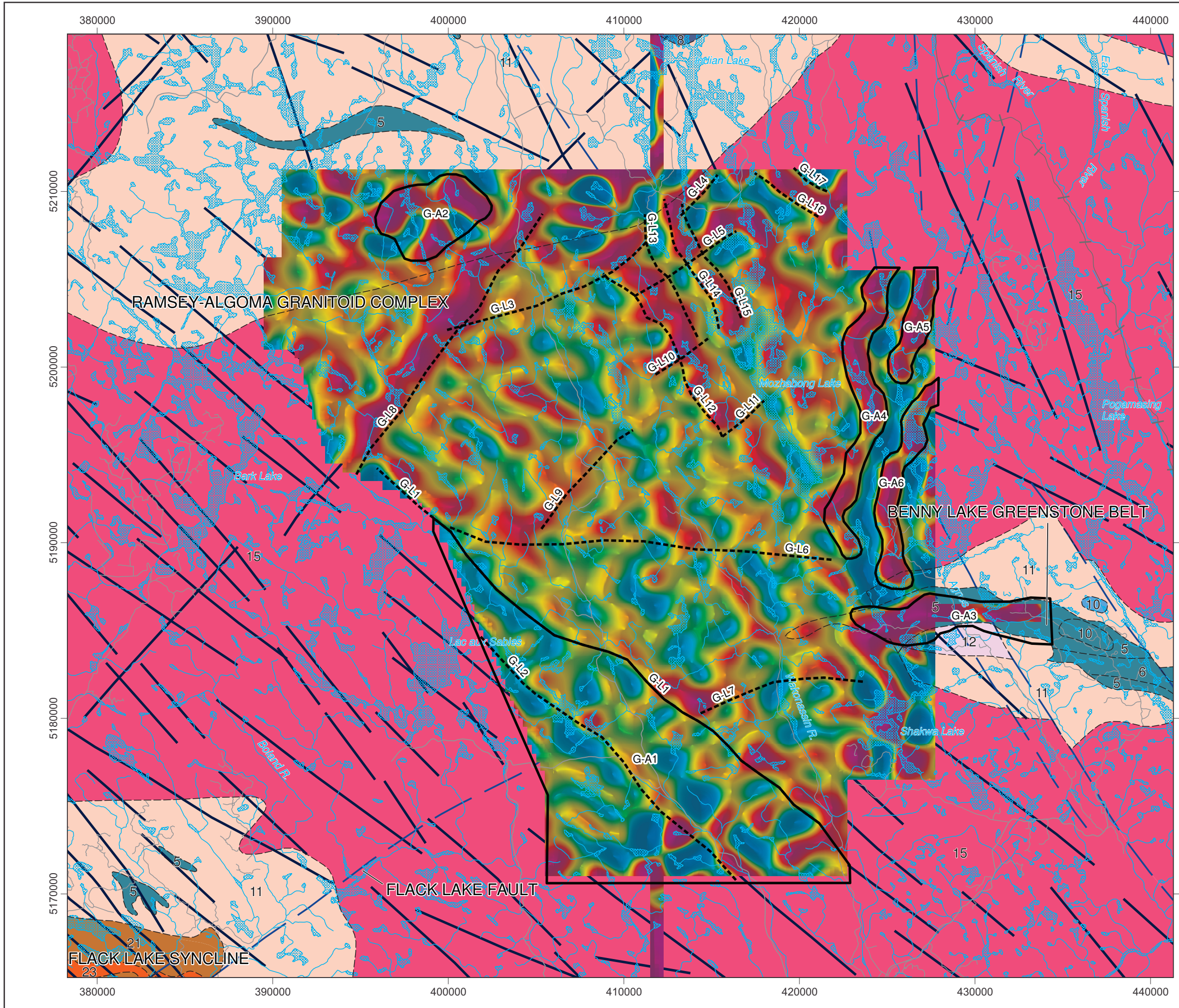


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Bouguer Gravity
 (terrain correction density = 2.67 g/cm³) (250 m cell)
 with Selected Interpreted Features

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 5.1
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

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8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

Gravity Anomaly

Gravity Lineament

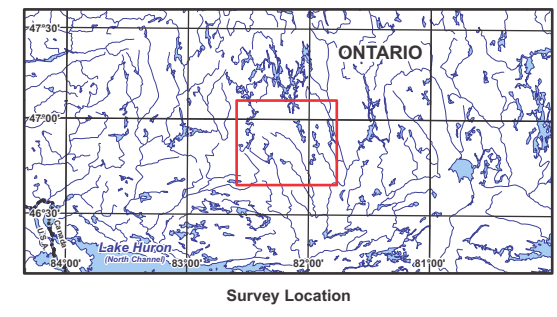
Map Parameters

Illumination: inclination 50°, declination 270°

Spatial Filter (half-wavelength): 1000 m

Bouguer Density: 2.67 g/cm³

Eötvös



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universal Transverse Mercator (UTM Zone 17N)

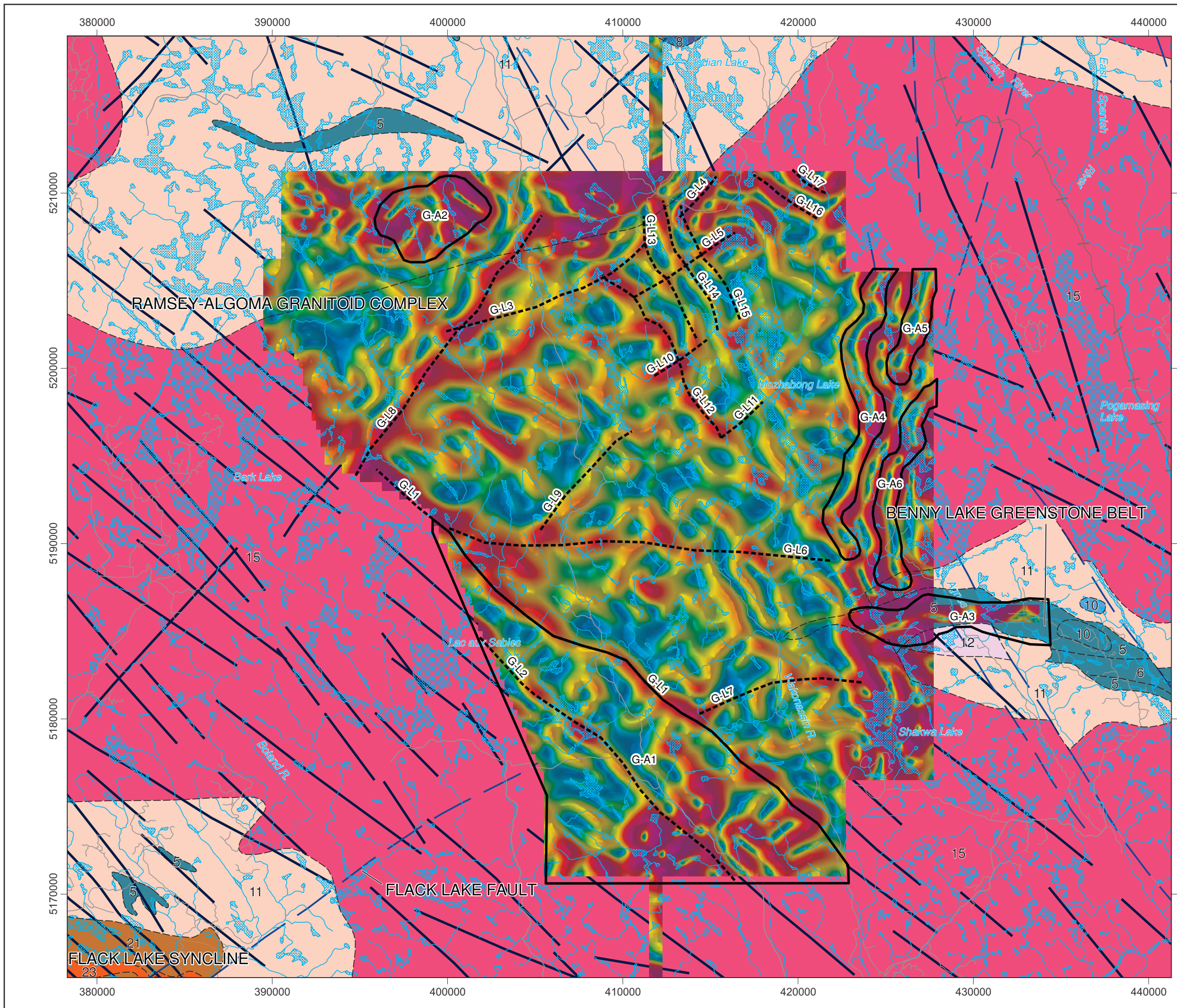


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

First Vertical Derivative of the Bouguer Gravity
 (terrain correction density = 2.67 g/cm³) (250 m cell)
 with Selected Interpreted Features

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 5.2
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

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7: Metasedimentary rocks

6, 5: Metavolcanic rocks

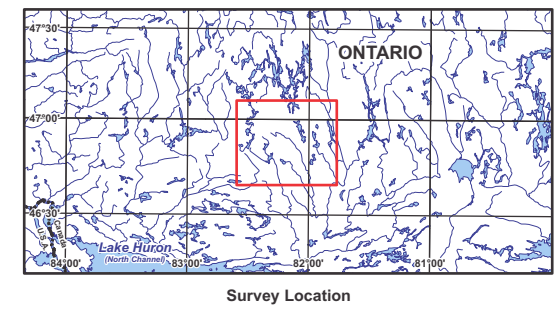
Gravity Anomaly

Gravity Lineament

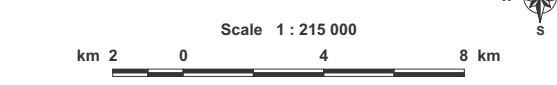
Map Parameters

Illumination: inclination 50°, declination 270°

mGal/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universal Transverse Mercator (UTM Zone 17N)

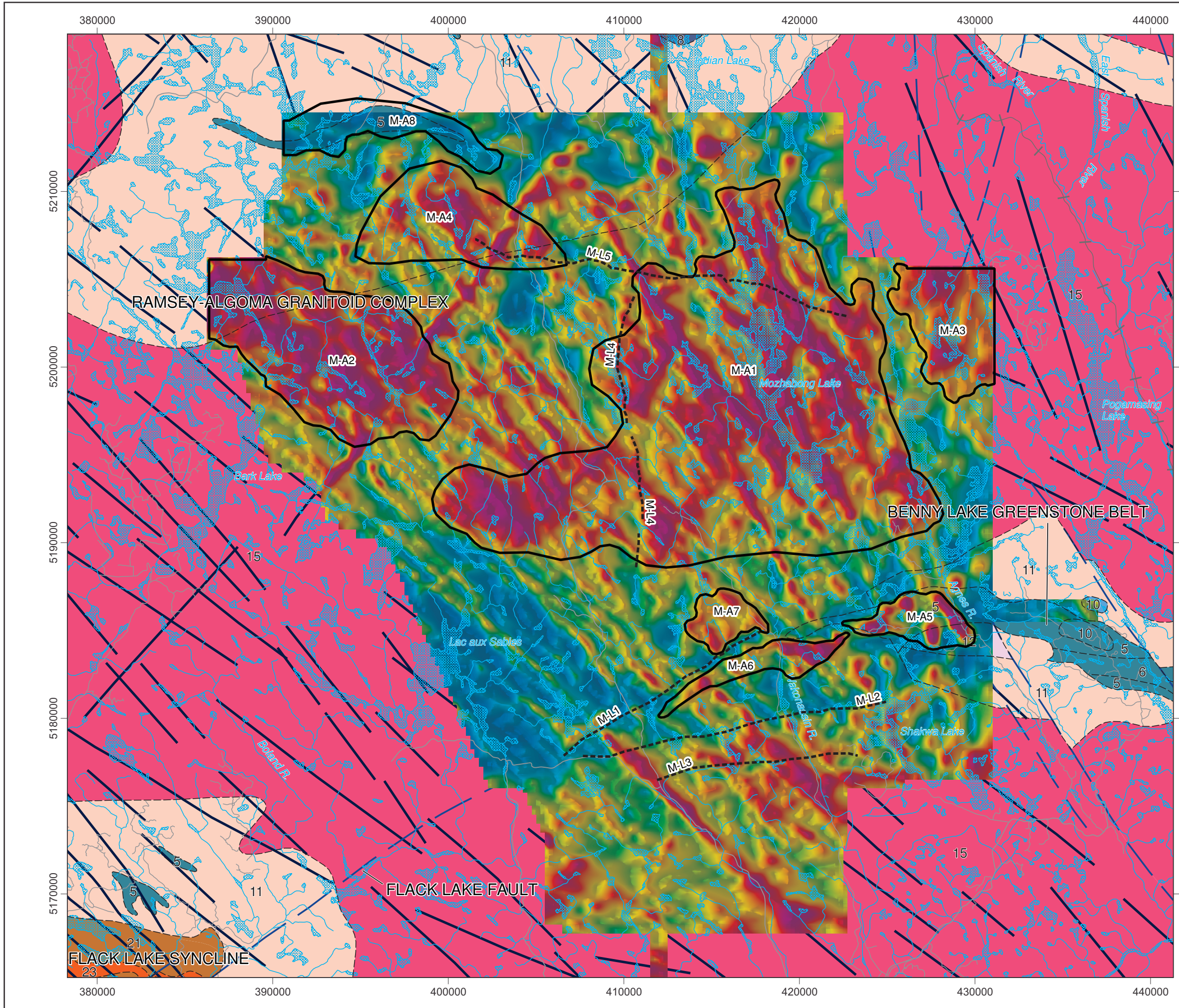


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the Bouguer Gravity
 (terrain correction density = 2.67 g/cm³) (250 m cell)
 with Selected Interpreted Features

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 5.3
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

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8: Migmatized supracrustal rocks

7: Metasedimentary rocks

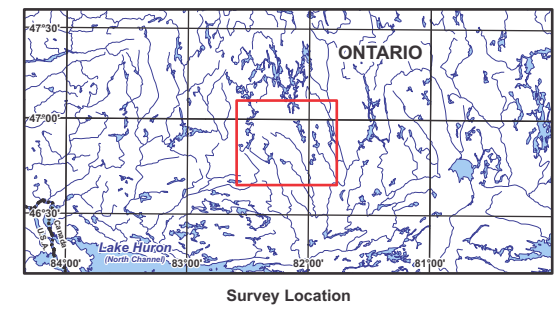
6, 5: Metavolcanic rocks

Magnetic Anomaly

Magnetic Lineament

Map Parameters

Illumination: inclination 50°, declination 270°



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

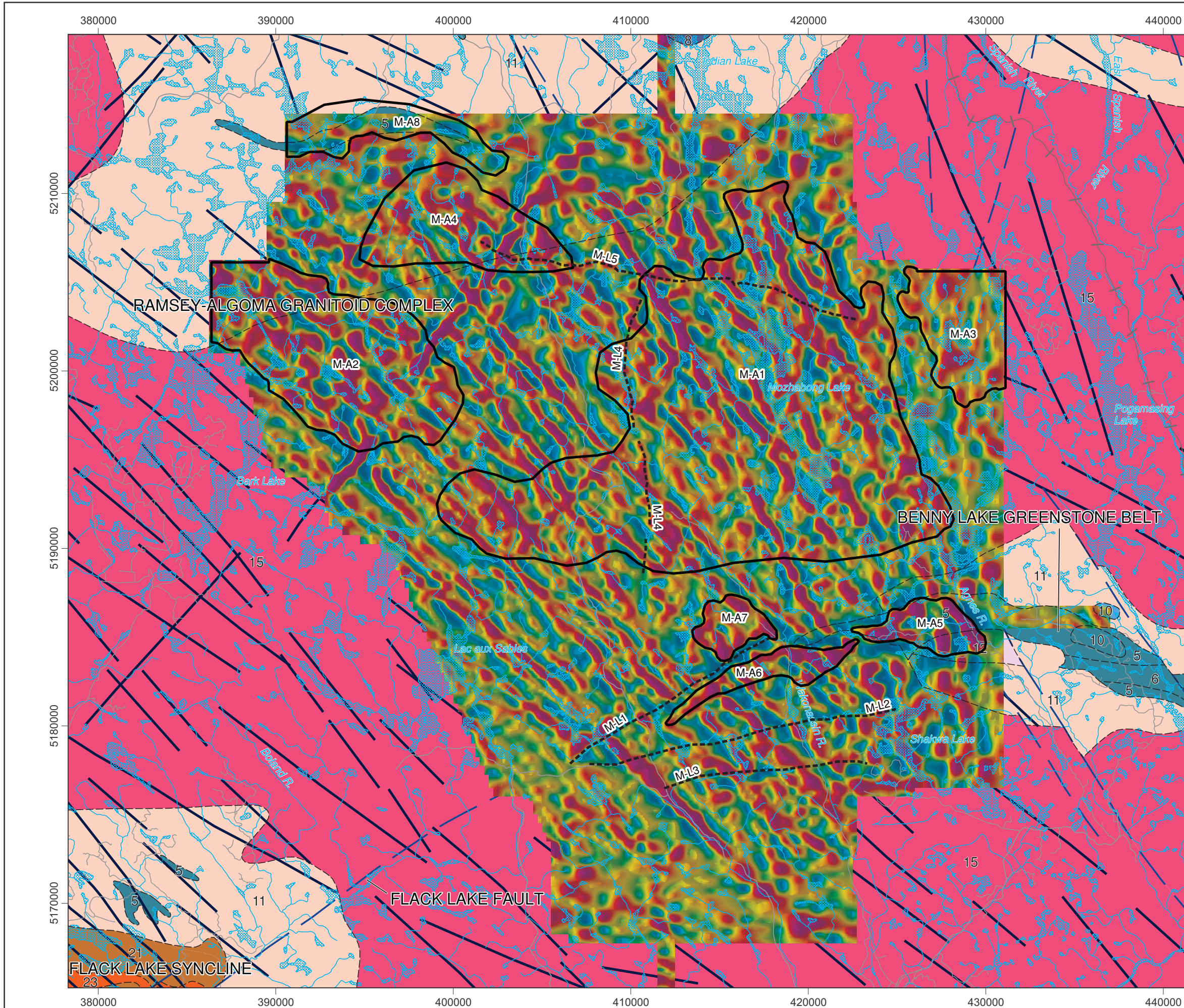


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

**Reduction to the Pole
 of the Total Magnetic Intensity (250 m cell)
 with Selected Interpreted Features**

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 5.4
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

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Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

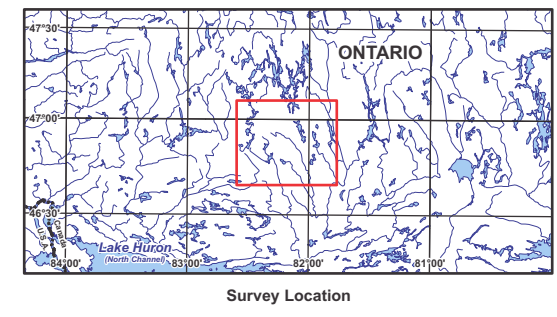
Magnetic Anomaly

Magnetic Lineament

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universal Transverse Mercator (UTM Zone 17N)

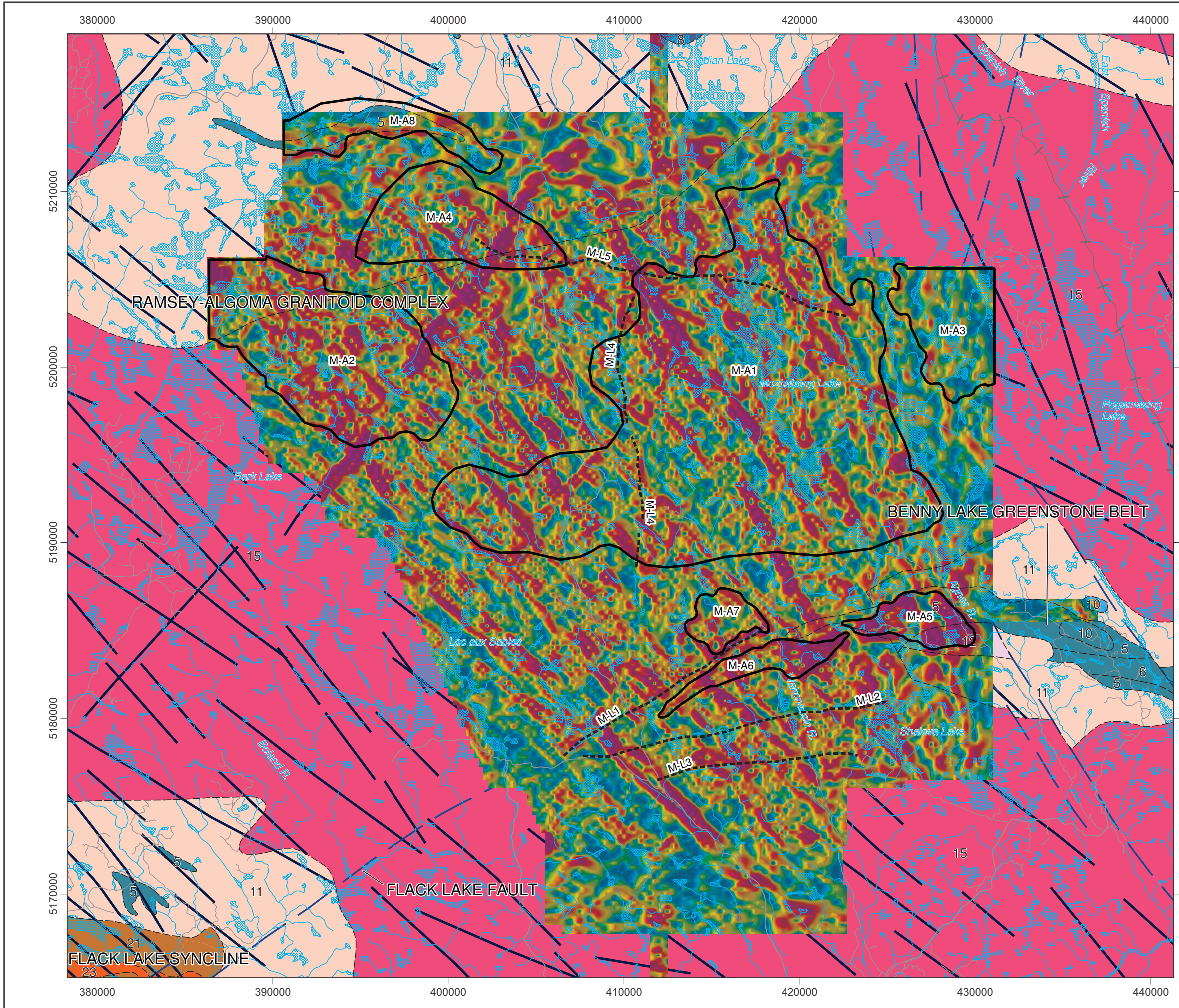


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

First Vertical Derivative of the Reduction to the Pole
 of the Total Magnetic Intensity (250 m cell)
 with Selected Interpreted Features

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 5.5
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



Legend

Hydrography

Roads

Railway

Powerline

Pipeline

Geology

Fault

Dyke

Proterozoic

37, 35, 30, 27, 23: Various rock units of the Southern Province

21, 20, 19, 18: Huronian Supergroup

17: Mafic and ultramafic intrusive rocks and mafic dykes; Archean-Superior Province (Abitibi Subprovince)

Archean

15: Massive granodiorite to granite

14, 12: Archean granatoid suites

11: Gneissic tonalite suites

10: Mafic and ultramafic rocks

8: Migmatized supracrustal rocks

7: Metasedimentary rocks

6, 5: Metavolcanic rocks

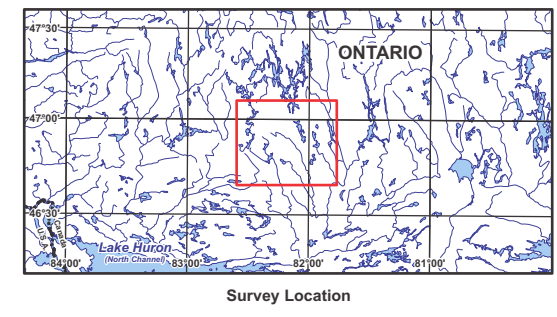
Magnetic Anomaly

Magnetic Lineament

Map Parameters

Illumination: inclination 50°, declination 270°

nT/km



BASE DATA: National Topographic Database - NRCAN
 GEOLOGY DATA: OGS M-Series maps: M2670 & MRD126-rev1
 DATUM: NAD83
 PROJECTION: Universe Transverse Mercator (UTM Zone 17N)

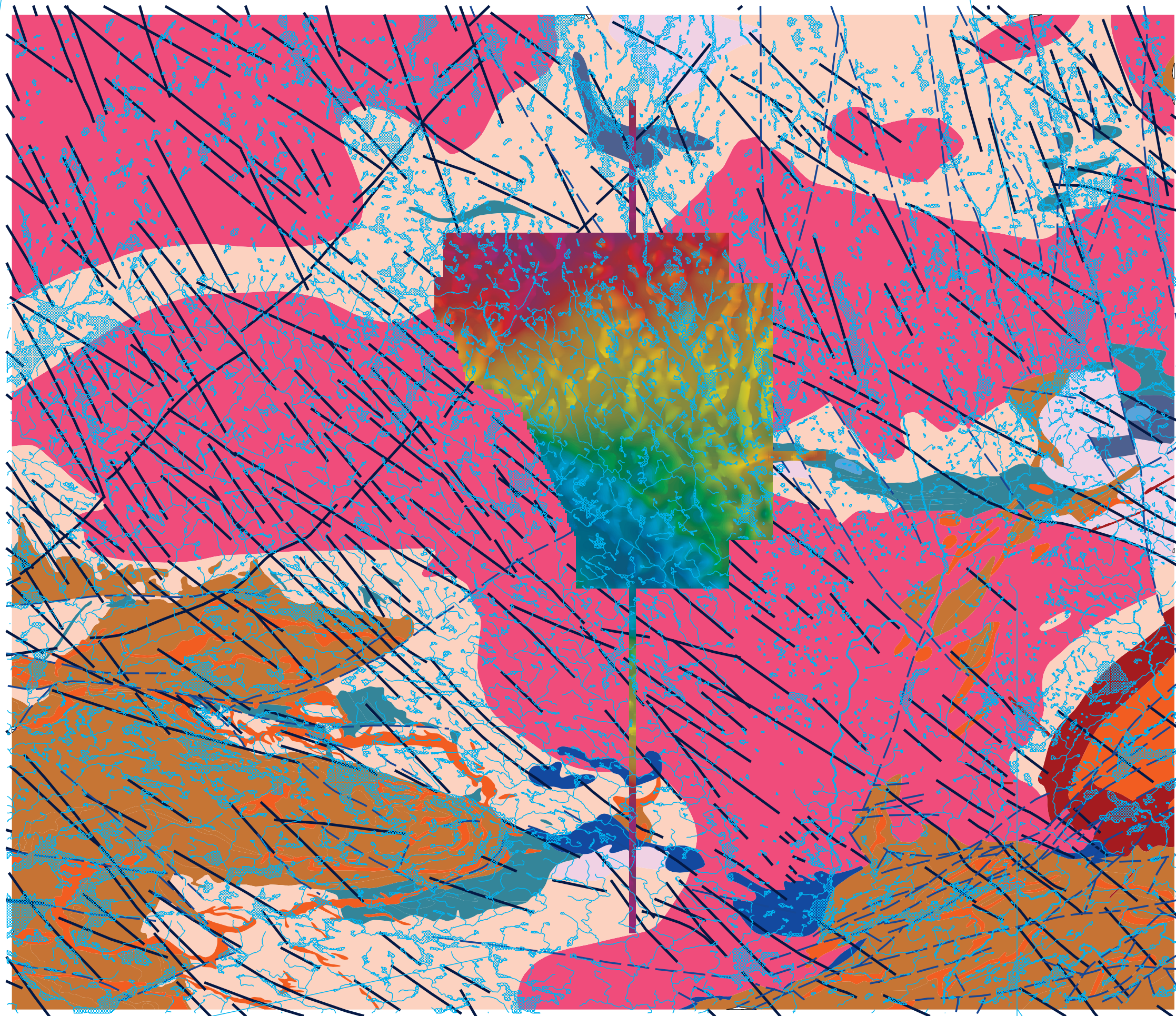


**Airborne Geophysics
 Acquisition and Interpretation**

Elliot Lake and Blind River Area, Ontario 2016

Total Horizontal Derivative of the Reduction to the Pole
 of the Total Magnetic Intensity (250 m cell)
 with Selected Interpreted Features

	DESIGN	JK	26/06/2017	REV. 1.0
	GIS	YC	26/06/2017	FIGURE: 5.6
	DATA	MM, AS, AP	26/06/2017	
	QC	MB	29/06/2017	



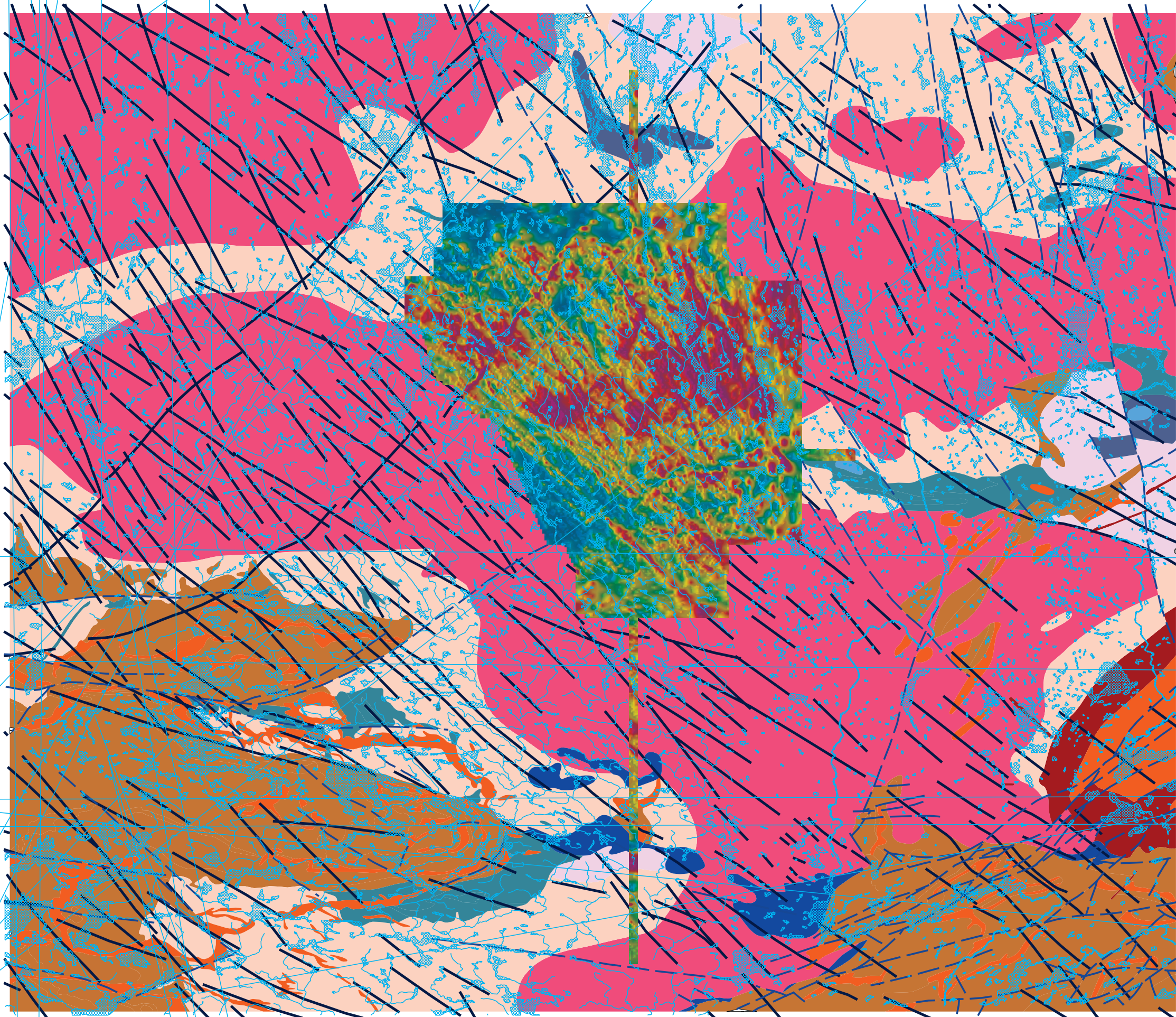


Figure 5.9 - Forward Modeling Results: Line 1, Elliot Lake and Blind River Area, Ontario

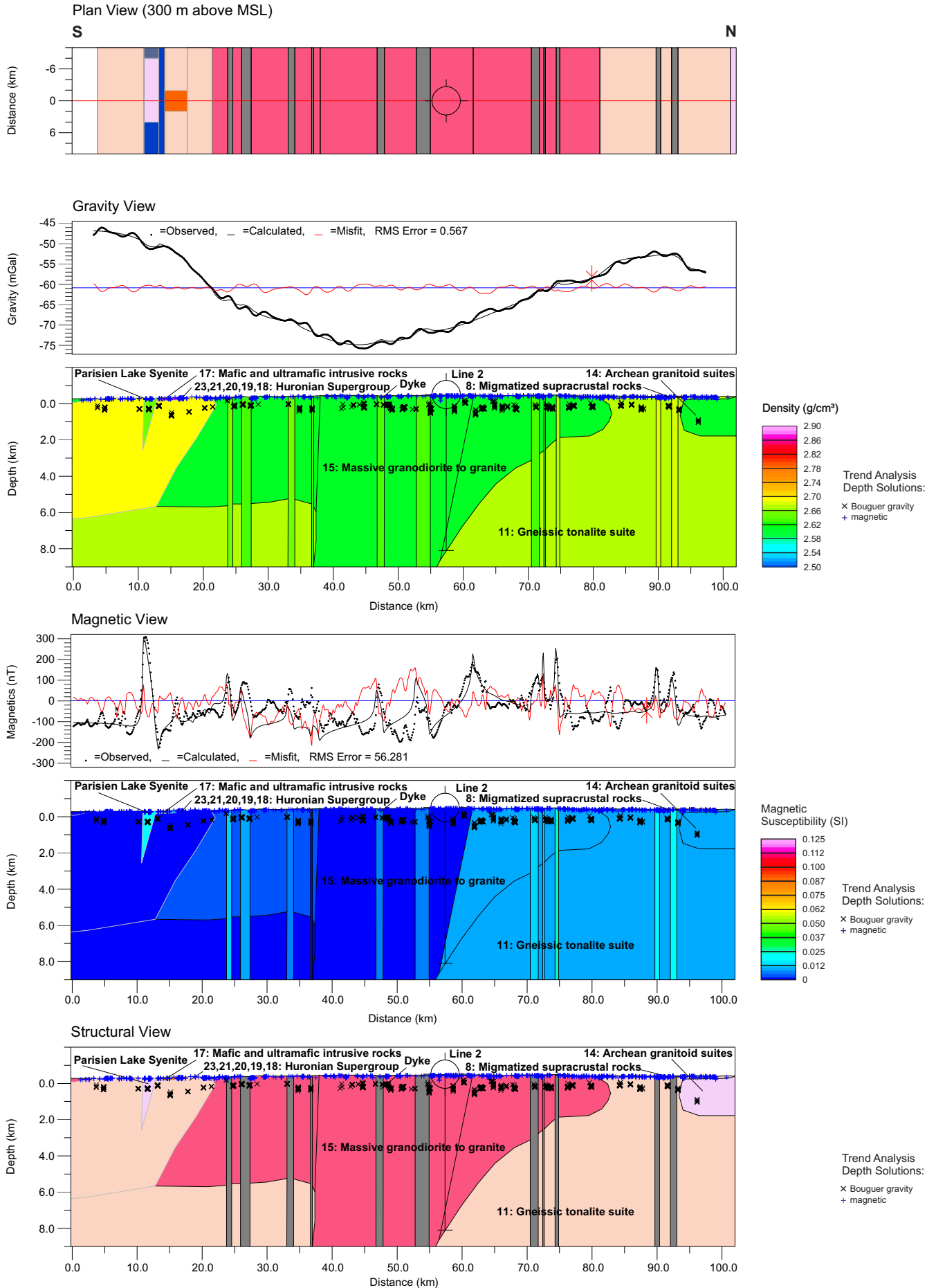


Figure 5.10 - Forward Modeling Results: Line 1-Alternative, Elliot Lake and Blind River Area, Ontario

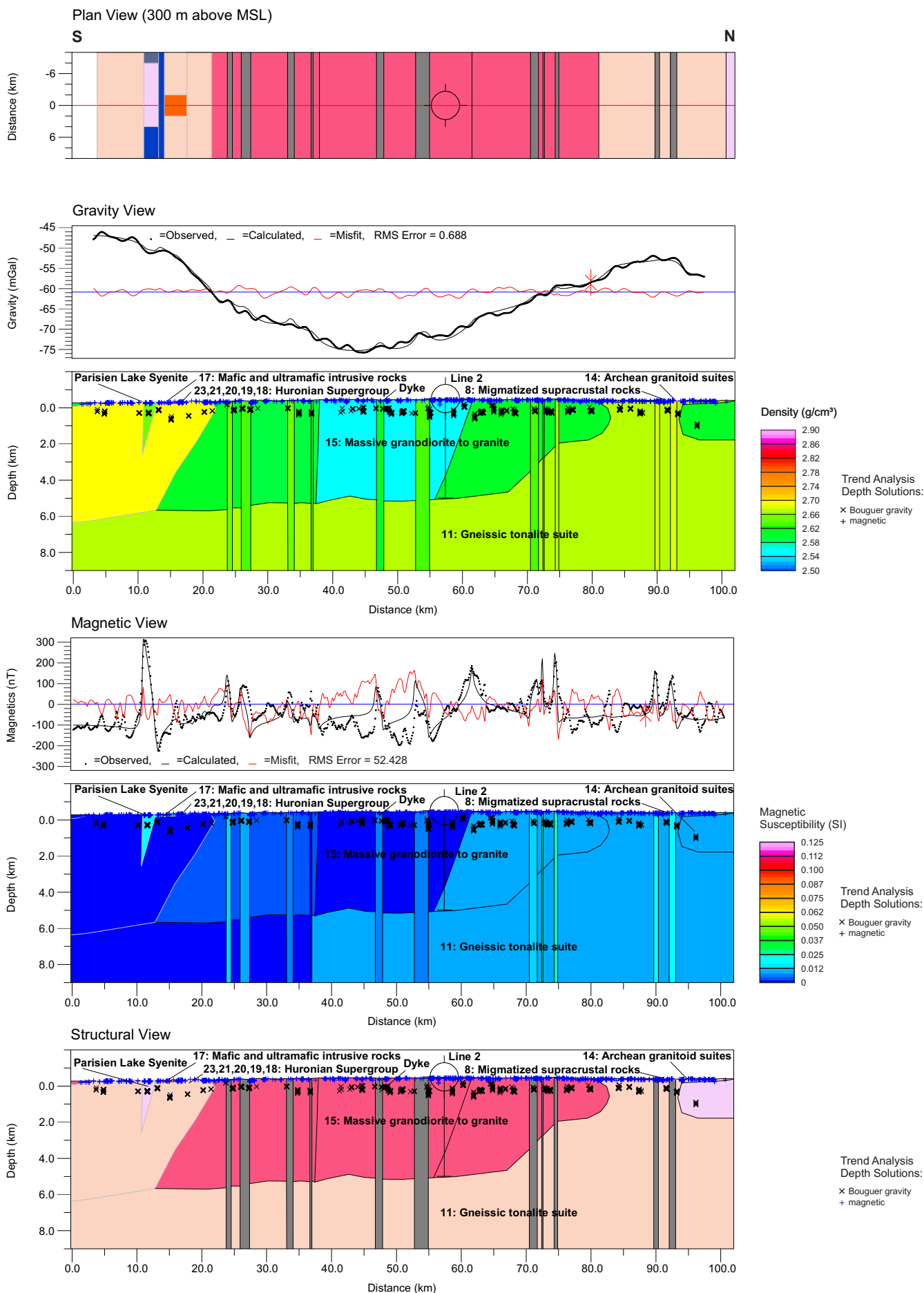


Figure 5.11 - Forward Modeling Results: Line 2,
Elliot Lake and Blind River Area, Ontario

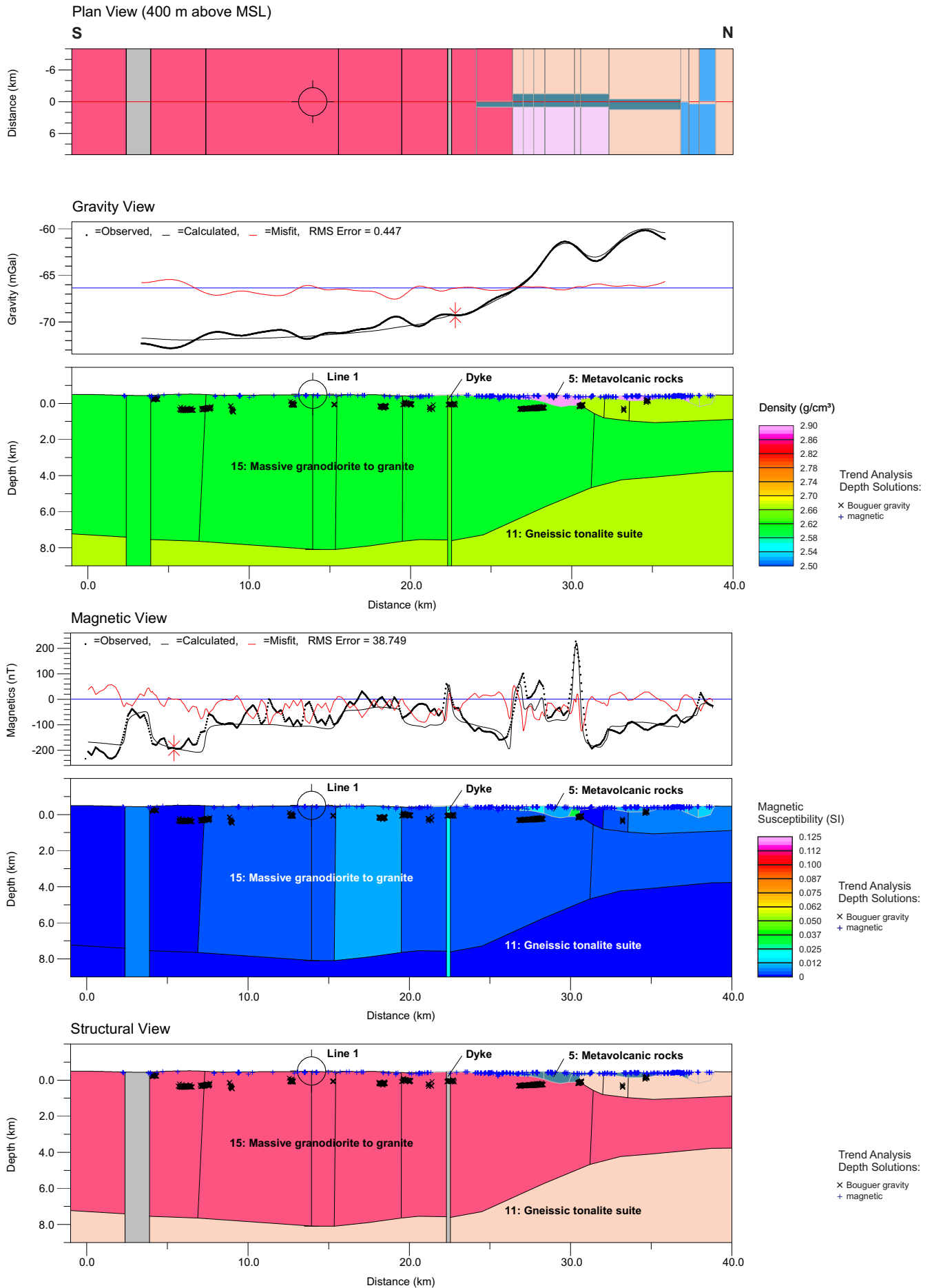


Figure 5.12 - Forward Modeling Results: Line 2-Alternative, Elliot Lake and Blind River Area, Ontario

