AIRBORNE MAGNETOMETER SURVEY
FOR
RUBICON MINERALS CORPORATION
POST NARROWS BLOCK
RED LAKE, ONTARIO

NTS 52N

Fugro Airborne Surveys Corp.
Mississauga, Ontario

May, 2002

Emily Farquhar M.Sc.
Geophysicist
SUMMARY

This report describes the logistics and results of an airborne magnetometer survey carried out for Rubicon Minerals Corporation over a survey block located in Dome and McDonough Townships in the Red Lake area, Ontario. The traverse lines accounted for 285.8 line kilometres and the tie lines 30.7 kilometres for a total of 316.5 km. The survey was flown from March 3 to March 11, 2002.

The purpose of the survey was to record detailed magnetic data over the block to provide information that could be used to map the geology and structure of the survey area. This was accomplished by using a gradient array of high sensitivity cesium magnetometers. The information from these sensors was processed to produce maps that display the magnetic properties of the survey areas. A GPS electronic navigation system, combined with a GPS base station and post processing of the positional data, ensured accurate positioning of the geophysical data with respect to the base maps.
APPENDICES

A. List of Personnel
B. Background Information
C. Archive Description
D. Total Magnetic Field Contour Maps
1. INTRODUCTION

A magnetic survey was flown for Rubicon Minerals Corporation from March 3 to March 11, 2002 over fourteen (14) claim blocks located in Dome and McDonough Townships in the Red Lake area of Ontario. The survey area can be located on NTS map sheet 52N/4 (Figure 1). The land is held by Rubicon Minerals Corporation

Suite 888, 1100 Melville Street
Vancouver, BC
V6E 4A6

Full survey coverage consisted of 316.5 line-km, including tie lines. Total distance flown over the mining lands covered in claims 1022728, 1022729, 1022732, 1022734, 1022735, 1022736, 1022737, 1022738, 1231807, 1231808, 1231809, 1231811, 1231982, 1231983 was 101.8 kilometres. Flight lines were flown at an azimuth of N 135 E with a traverse line separation of 50 metres.

The survey area and general flight specifications are as follows:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traverse Line direction:</td>
<td>N135°E</td>
</tr>
<tr>
<td>Tie Line Direction:</td>
<td>NO45°E</td>
</tr>
<tr>
<td>Nominal Traverse Line Spacing:</td>
<td>50 m</td>
</tr>
<tr>
<td>Nominal Tie Line Spacing:</td>
<td>500 m</td>
</tr>
<tr>
<td>Nominal Survey Altitude</td>
<td>60 m AGL</td>
</tr>
<tr>
<td>Nominal Sensor Altitude</td>
<td>30 m AGL</td>
</tr>
</tbody>
</table>

The extent of Post Narrows Block was defined by the following coordinates:

<table>
<thead>
<tr>
<th>Min X</th>
<th>Max X</th>
<th>Min Y</th>
<th>Max Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>442370</td>
<td>445270</td>
<td>5659190</td>
<td>5663940</td>
</tr>
</tbody>
</table>

Area coordinates (UTM projection, NAD 83 datum, Zone 15N)
FIGURE 1

POST NARROWS BLOCK, NTS 52 N/04
The survey employed three magnetometers, radar and laser altimeters, video camera, analog and digital recorders, and an electronic navigation system. The instrumentation was installed in a Eurocopter AS350B3 helicopter, Registration C-GECL provided by Questral Helicopters.

The mean terrain clearance adopted for the aircraft and instrumentation during normal survey flying was 60 metres. Actual terrain clearance of the aircraft varied, but was maintained as near to 60 metres as possible given safety considerations. A line was not accepted if height variations ±15% of the nominal survey altitude persisted for distances in excess of 1.0 kilometres, except where dictated by safety considerations.

Aircraft ground speed was maintained at approximately 100 km/h, equivalent to a maximum ground speed of 30 metres/second. The data were recorded using a 0.1 second sample interval, which resulted in geophysical measurements approximately every 3 metres along the survey lines. Sampling rates for data in each channel are specified in the table below.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>SAMPLING RATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesium Vapour</td>
<td>0.1 sec</td>
</tr>
<tr>
<td>Magnetometers</td>
<td>0.1 sec</td>
</tr>
<tr>
<td>Radar Altimeter</td>
<td>0.1 sec</td>
</tr>
<tr>
<td>Laser Altimeter</td>
<td>0.1 sec</td>
</tr>
<tr>
<td>GPS Navigation</td>
<td>0.5 sec</td>
</tr>
</tbody>
</table>
Section 2 provides details on the survey equipment, the data channels, their respective sensitivities, and the navigation/flight path recovery procedure.

2. SURVEY EQUIPMENT

This section provides a brief description of the geophysical instruments used to acquire the survey data and the calibration procedures employed.

Survey Equipment (Summary)

Airborne System:

- Fugro Heligrad 3D-Gradient Magnetics System
- Fugro Helidas Digital Acquisition System
- Picodas PNAV2100 Navigation System
- Novatel 3951R GPS for navigation control
- Novatel Millenium Dual frequency GPS for bird positioning
- Panasonic VCR with Sony Camera colour flight path video recording system
- Optech Laser Altimeter
- Sperry Radar Altimeter

Ground Support Equipment:

- Fugro CF1 Base Station complete with a CS-2 Cesium Magnetometer and Novatel Millenium Dual-frequency GPS receiver
- Pentium PC based Field Computer

Fugro 3D-Gradient Magnetics System – General Description

The Fugro Heligrad 3D-Gradient Magnetics system is essentially a two-axis magnetic gradiometer system. Three magnetometer sensors are deployed in a “T” configuration. Two magnetometer sensors are mounted on either end of a horizontal bar transverse to
the long axis of the bird. A distance of 3.0 metres separates these sensors. The difference in readings between these two sensors gives rise to the transverse horizontal magnetic gradient. The third sensor is mounted at the base of a 3.0 metre vertical strut. The difference between this magnetometer sensor and the average of the two transverse sensors gives the vertical magnetic gradient. The third gradient, inline horizontal magnetic gradient, is determined during post-flight processing of all three sensors.

Precise positioning of the bird is achieved by mounting the GPS antenna on the nose cone of the Heligrad bird. The GPS receiver inside the helicopter logs the raw GPS data for accurate flight path recovery using post-flight differential GPS corrections.

Accurate measurements of the height of the Heligrad bird above the ground are achieved through the use of a laser altimeter mounted inside the nose cone of the bird. As the gradient sensor system moves through the air, some non-linear movement such as bird roll, pitch and yaw are to be expected. Measurement of these movements is calculated from positional information supplied by three (3) dual-frequency GPS antennas mounted in the horizontal plane of the bird. The Fugro Heligrad 3D gradient sensor system comprises the following components:

- Three (3) Scintrex CS2 Cesium Magnetometers
- One (1) Optech G-150 laser altimeter
- Three (3) Novatel Millenium dual-frequency GPS receivers for determining bird attitude and position

**Airborne Magnetometer**

**Model:** Fugro HM7 processor with three (3) Scintrex CS2 sensors

**Type:** Optically pumped cesium vapour
Sensitivity: 0.01 nT
Sample rate: 10 per second

A cesium magnetometer sensor comprises a miniature atomic absorption unit from which a signal proportional to the intensity of the ambient magnetic fields is derived. An electronic console converts this signal (called a Larmor signal) into magnetic field strength in nanoTeslas (nT) for display and recording by a data acquisition system. The constant of proportionality, which relates the Larmor signal to the intensity of the magnetic field, is called the "gyromagnetic ratio of electrons". For the Cesium-133 atom, this is very accurately known to be 3.49856 Hz/nT. This is about 82 times higher than the common proton precession magnetometer, and is the reason that the cesium magnetometer has a better sensitivity.

The three main elements of the cesium sensor are a cesium lamp, an absorption cell containing cesium vapour and a photosensitive diode, all mounted in a common optical axis. This sensor element is then typically connected by a 3 metre long multi-conductor coaxial cable to another cylinder, which contains the electronics for the sensor.

Three magnetometer sensors are housed in the bird, 30 m below the helicopter.

**Optech G-150 Laser Altimeter**

The Optech G-150 Laser altimeter is a compact, non-contact measurement system designed to give highly accurate readings in an integrated flight inspection system. It can operate during the day or at night, but is primarily a clear-weather instrument.

The unit is designed such that the laser light can be reflected from a diffuse surface, such as the ground, at virtually any angle and still return to the unit to produce a measurement.
The use of a narrow beam eliminates echoes that can cause distorted distance readings. The sensor was mounted inside the nose cone of the 3D Gradient bird to provide a true height of the sensor above the ground. The laser altimeter provides 1.0 mm resolution with an accuracy of +/- 2 cm. A reading is obtained from the altimeter every 0.1 seconds.

**Radar Altimeter**

Manufacturer: Honeywell/Sperry  
Model: RT330  
Type: Short pulse modulation, 4.3 GHz  
Sensitivity: 0.3 m

The radar altimeter measures the vertical distance between the helicopter and the ground.

**Digital Data Acquisition System**

Manufacturer: Fugro Airborne Surveys  
Model: Helidas  
Recorder: Flash Card

The Helidas is a new member of the Fugro family of data acquisition systems and is used exclusively in airborne geophysical surveying. The three main functions fulfilled by the Helidas are 1) system control and monitoring 2) data acquisition and 3) data analysis.
The Helidas has the GPS receiver directly connected to the data system to provide a high-speed clock that is synchronized with the GPS time. The time base is also included in the MP7 mag processor to allow for precise positioning of the geophysical data relative to the positional information. A modular concept has been used for both the hardware and software to allow for future expandability. The sensors used with the Helidas may include magnetic, electromagnetic and radiometric. Other instruments such as navigation, altimeters or video are also readily interfaced. The Fugro XYZLogger runs on the Helidas and allows the user to configure the contents of the output data stream. This output data is saved in a Geosoft compatible ASCII file format.

The data are stored on a 48Mb flash card and are downloaded to the field workstation PC at the survey base for verification, backup and preparation of in-field products.

**Video Flight Path Recording System**

Type: Panasonic VHS Colour Video Camera (NTSC) and VCR

Model: Camera: Sony DXC-101; VCR: Panasonic AG-720

In order to verify the position of the aircraft in relation to the recorded geophysical data and to allow for identification of cultural features, Fugro included a VHS video camera and recorder in this system. Fiducial numbers are recorded continuously and are displayed on the margin of each image. This procedure ensures accurate correlation of analog and digital data with respect to visible features on the ground.
Navigation (Global Positioning System)

Global Positioning Systems, or GPS, is a system that provides accurate positional information based on signals received from a constellation of at least 24 satellites. The US Department of Defense originally developed GPS primarily for military use but GPS brings a number of important benefits to aerial surveying. First, the coordinates of the survey aircraft (horizontal and vertical) are provided on a continuous basis. This not only improves the quality of survey navigation and reduces its cost, it also simplifies data compilation and presentation by eliminating, to a large degree, the tedious and error-prone manual steps of flight path recovery from film or video. Secondly, GPS provides a reusable positioning system. Surveys flown at different times in the same area may be precisely correlated in position, making it easy to repeat survey lines or to fly gap-filler lines, etc.

The Fugro GPS system is based on the Novatel Millenium GPS receivers, and includes the following:

- The Fugro PNAV-2001 Navigation Interface/Display Computer
- 1 Novatel 3951R GPS receiver (one antenna mounted on helicopter)
- 3 Novatel Millenium GPS antennas mounted on the bird
- A differential base station utilising a Novatel Millenium located at the base station site, for post-survey differential corrections.

The Fugro GPS system is configured in the following manner: the 3951R mounted on the helicopter passes raw GPS position to the PNAV. The PNAV compares the raw data with the planned flight path and updates the flight path information in the operator's LCD panel and on the navigation display for the pilot. The data acquisition system also collects the data from the GPS and stores it for later use in differential corrections. The
Novatel Millenium GPS units mounted on the bird self-store their GPS data and post-processing of this data allows for accurate positioning of the geophysical data and determination of the attitude of the bird.

A Novatel Millenium GPS receiver is also located at the base station site. Base station fixes are logged to an on-board static memory device. At the end of each flight, the base and remote static memory devices are downloaded to a PC for post-flight differential corrections.

Accuracy of the post-survey differentially corrected positions is better than ± 0.5 metres

Airborne Receivers

Helicopter
Model: Novatel 3951 R
Type: Single frequency, 12 channels, GPS/Glonass capability
Accuracy: Manufacturer's stated accuracy for differential corrected GPS is <1 metre

The airborne GPS antenna was installed on the tail of the helicopter.

Bird
Model: Three (3) Novatel Millenium GPS receivers
Type: Dual frequency, 12 channels, full wavelength carrier on L1 and
Accuracy: Manufacturer's stated accuracy for differential corrected GPS is <1 metre

Base Station
Model: Novatel Millenium GPS receiver
Type: Dual frequency, 12 channels, full wavelength carrier on L1 and L2
Accuracy: Manufacturer's stated accuracy for differential corrected
The Novatel Millenium GPS unit is operated as a GPS base station and utilizes time-coded signals from at least four of the NAVSTAR satellites. The raw base station data are recorded permitting post-survey processing for theoretical accuracy of better than 0.5 metre. The GPS records data relative to the GRS80 ellipsoid, which is the basis of the revised North American Datum (NAD83). The Novatel Millenium base was used as the primary unit for post processing.

Although the base station receiver is able to calculate its own latitude and longitude, a higher degree of accuracy can be obtained if the reference unit is established on a known benchmark or triangulation point. For this survey, the base station position was not tied to any known reference point. The GPS base station was located at the Red Lake Airport, Ontario, near the helicopter landing pad. The GPS base station location was determined to be at latitude 51° 04' 01.31799" N, longitude 93° 48' 14.26977" W at an elevation of 357.75 metres above the WGS84 ellipsoid.

Magnetic Base Station

The CF1 Base Station Cesium Magnetometer is a high-sensitivity cesium magnetometer designed for base station applications where a high resolution is required. The cesium sensor of the CF1 is mounted on a non-magnetic tripod and is connected to a processor and PC-Datalogger by a long sensor cable. The CF1 operates from a 24 VDC power source.
The CF1 features:
- 0.01 nT resolution over 20,000 nT to 100,000 nT range
- high gradient tolerance
- automatic tuning
- sampling rate of up to 10 times per second
- real-time datalogger for storage onto removable FLASH memory card
- data displayed on LCD screen as Magnetic Field, GPS time, and non-linear variation over a 1 minute chord
- operates on 24 VDC power

The CF1 Cesium Base Station Magnetometer comprises the following:
- a magnetometer processor card
- a cesium sensor mounted on a nonmagnetic tripod
- a 20m long sensor cable
- a 24 VDC power supply
- removable FLASH memory card for data storage

**Primary Base Station Magnetometer:**

Model: Fugro CF1 base station

Sensor type: Scintrex CS2 cesium vapour

Counter specifications: Accuracy: ±0.1 nT
Resolution: 0.01 nT
Sample rate: 1 Hz

Sensitivity: 0.10 nT

Sample rate: 0.2 per second

**Secondary Base Station Magnetometer:**

Model: GEM Systems GSM-19

Sensor type: Overhauser Magnetics

Counter specifications: Accuracy: ±0.1 nT
Resolution: 0.01 nT
Sample rate: 1 Hz

Sensitivity: 0.10 nT

Sample rate: 3.0 seconds
The primary base station magnetometer was located at latitude 51° 04' 15.9402" N, longitude 93° 47' 49.7906" W at an elevation of 345 metres above the WGS84 ellipsoid. A digital recorder is operated in conjunction with the base station magnetometer to record the diurnal variations of the earth's magnetic field. The clock of the base station is synchronized with that of the airborne system through the GPS clock to permit subsequent removal of diurnal drift.

**Field Workstation**

A PC is used at the survey base to verify data quality and completeness. Flight data are transferred to the PC hard drive to permit the creation of a database using a proprietary software package and Geosoft Oasis Montaj. This process allows the field operators to display both the positional (flight path) and geophysical data on a screen or printer.

The in-field processing consisted of the following steps:

- Post-flight processing of the raw GPS locations (base and remote) to create a differentially corrected position file.
- Import of survey data into OASIS montaj™ database.
- Flight path generation and validation.
- Inspection of magnetic, GPS and terrain clearance for Quality Control.
- Correction of magnetic data for diurnal variation and IGRF.

Final data processing, data archiving and reporting was completed at the Fugro Airborne Surveys Limited offices in Mississauga, Ontario.

**Field Personnel**
The survey crew consisted of the following personnel:

Systems Operator: Michael Senko
Geophysicist / Data Processor: Darcy McGill
Pilot: Terry Thomson
Engineer: NONE

Technical expertise provided by Philip Miles.

General project management was under the responsibility of David Miles, Operations Manager, Fugro Airborne Surveys.
3. PRODUCTS AND PROCESSING TECHNIQUES

Data Compilation

Differential GPS Corrections
Following each flight, the raw GPS files are extracted from the base and remote GPS receivers and their contents transferred to a PC workstation computer. These data are then combined and processed to create a file containing the final differentially corrected GPS locations. The coordinates generated are in WGS-84 latitude and longitude and height above the WGS-84 spheroid in metres. The data from the three on-bird Millenium units are used to create three bird “attitude” channels – pitch, roll and heading.

Magnetic Data
The magnetic data was corrected to produce measured gradients and a final levelled total field product by the application of the following sequence of procedures:

- Data quality check on the raw magnetic data.
- Loading, checking and application of the measured diurnal data.
- Lag correction.

The data quality check was accomplished in the field by applying a fourth difference filter to the raw magnetic data after it had been loaded into the OASIS Montaj™ database. Plotting the raw and filtered data together permitted tracking the performance of the magnetometer sensor as well as monitoring the noise levels that were superimposed on the data during survey activities. Magnetometer noise levels were maintained within stated specifications.
The aeromagnetic data were inspected in both grid and profile format. Spikes were removed manually with the aid of a fourth difference calculation and small gaps were interpolated using an Akima spline.

A lag correction is then applied to remove the effects of temporal delay inherent in the data acquisition system. The lag tests performed prior to the start of the survey indicated a correction of 0.7 seconds was required for the geophysical data. These lagged magnetic channels provide the starting point for the gradient processing.

Data acquired from the Fugro CF1 base station are loaded into the Oasis database. The GPS time, acquired both in the ground base station system and in the airborne data acquisition system, provides the synchronization parameter for the merging of the data sets. The diurnal magnetic data had a base of 59250.0 nT removed, was inspected and filtered, then subtracted from the total field magnetic data after QC and lag corrections described above are applied. Grids were created and compared to the non-diurnally corrected data to ensure diurnal removal resulted in a better quality of data. These channels provide the starting point for the TMI data processing.

Two stages of levelling are applied to the total magnetic intensity prior to the generation of the images and contour plots: these are tie-line levelling and microlevelling.

Tie line levelling is carried out by adjusting the intersection points on the traverse lines, such that the differences are minimized with the control lines. To achieve this, a levelling intersection network is established and weights at each intersection assigned according to the local magnetic gradients. Visual examination of the intersections for each tie-line is possible if manual editing of intersection corrections is required. Tie line levelling was only used on lines which had two intersections with tie lines. Manual adjustments were applied
to any lines that required additional levelling, as indicated by shadowed images of the gridded vertical gradient. For the Red Lake survey many of the tie line intersections were rejected due to the extreme magnetic gradients in the survey area and due to altitude differences between tie lines and control lines at intersection points. In general, tie-line levelling was seen to degrade the data set from the diurnally corrected magnetic response. After the application of tie-line levelling, a procedure known as microlevelling can be applied. This technique is designed to remove any persistent, low-amplitude component of flight line noise remaining after tie-line levelling. A series of directional filters is applied to the magnetic grid to produce a decorrugation "noise" grid. This grid is then resampled back into the database where the resultant "noise" channel is further filtered to remove short wavelength responses that could be due to geologic sources. The amplitude of the "noise" channel is also limited to restrict the effect that the microlevelling might have on strong geologic response. Finally, the "noise" channel is subtracted from the tie-line levelled or diurnally corrected channel created earlier in the processing sequence, resulting in the final levelled channel.

**Gradient Calculation**

Following correction and validation of the 3 magnetic sensor data and the application of the lag correction, the transverse horizontal gradient and the vertical gradient are calculated directly from the three sensors. In addition, an inline horizontal gradient is calculated using the magnetic data from the lower sensor and the corrected XY locations. Corrections to all of these raw gradients are made for relative changes in the attitude of the towed bird. Attitude variations are estimated with pitch, roll and heading channels
calculated from three Novatel Millenium GPS receivers on each end of the horizontal bird structure. In the Post Narrows survey block there are also changes in the measured gradients from one survey line to the next that are correlated with changes in altitude. These effects required some microlevelling of the transverse and vertical measured gradients. The final total magnetic gradient channel was created by combining all three measured gradients at each survey point.

**Base Maps**

Base maps of the survey area have been produced from published topographic maps. These provide a relatively accurate, distortion-free base which facilitates correlation of the navigation data to the UTM grid. The original topographic maps are scanned to a bitmap format and combined with geophysical data for plotting the final maps. All maps are created using the following parameters:

**Projection Description:**

- **Datum:** NAD83
- **Ellipsoid:** GRS80
- **Projection:** UTM (Zone: 15)
- **Central Meridian:** 93° W
- **False Northing:** 0
- **False Easting:** 500000
- **Scale Factor:** 0.9996
- **WGS84 to Local Conversion:** Molodensky
- **Datum Shifts:** DX: 0 DY: 0 DZ: 0

**Table 3-1 Survey Products**

1. **Final Paper Maps** @ 1:10,000
Total magnetic intensity blackline contours
Total magnetic intensity colour image with blackline contours
Measured Vertical Magnetic Gradient blackline contours
Measured Vertical Magnetic Gradient colour image with blackline contours
Sunshaded colour image of Total Magnetic Intensity
Flight Path blackline plot

2. Additional Products

Digital archive including Geosoft format database and grids
Survey report (4 copies)
Analog chart records
Flight path videocassettes

The digital archive contained the following data:

- Raw airborne total field magnetic data (3 sensors)
- Raw base station magnetic data
- Levelled and IGRF corrected lower sensor total field magnetic data
- Levelled and corrected measured vertical magnetic data
- Levelled and corrected measured transverse magnetic gradient data
- Levelled and corrected measured inline magnetic gradient data
- Levelled measured total gradient data
- Raw and filtered laser altimeter data
- X,Y,Z positional data in NAD83 UTM Zone 15 coordinate system
- Profile of digital terrain elevation
- Radar altimeter data

This survey report includes logistical information pertaining to the survey and describes the data acquisition, processing and final presentation of the survey results. The survey report is delivered in four (4) separate copies with two of the reports being suitable for assessment purposes. The report is also included as a Microsoft Word document on the final CDROM archive.

Table 3-1 lists the maps and products that have been provided under the terms of the survey agreement. Other products can be prepared from the existing data, if requested.
Contour, Colour and Shadow Map Displays

The geophysical data are interpolated onto a regular grid using a modified Akima spline technique. No additional processing or filtering was applied to the final grids and the resulting grid is suitable for generating contour maps and colour/shadow images. The grid cell size is 12.5 metres.

Interpolating the grid cells before plotting produces smoothly varying colour maps. The geophysical parameter is then incremented with respect to specific amplitude ranges to provide colour "contour" maps. On maps where two survey grids are presented the colour histogram has been calculated to best show the features on both grids. Colour maps of the total magnetic field are particularly useful in defining the lithology of the survey area.

4. SURVEY RESULTS

Previous Work

Extensive work has been carried out in the Red Lake Area. Work completed by Rubicon in the survey area has been limited to surface sampling. The reader is referred to the publicly available assessment reports, filed at the resident geologists office in Red Lake, Ontario.

Physiography

Physiography and topography are typical of glaciated Precambrian areas. Dominant landforms are rounded rocky ridges and hills, interspersed with low ground. The hills and
ridges are generally elongated parallel to the strike direction of the underlying bedrock. Maximum relief on the islands surveyed during this program does not exceed 15 metres above lake level, with the greatest elevation at island centres.

**Regional Geology**

**Stratigraphy**

The Red Lake gold camp is situated in the Red Lake greenstone belt, an accumulation of Archean-age metavolcanic, metasedimentary and intrusive rocks comprising a portion of the Uchi Province of the Canadian Precambrian Shield.

The Red Lake district is underlain by Mesoarchean rocks that have been subdivided into three assemblages (Sandborn-Barrie et al., 1999): Balmer, Ball and Bruce Channel. Neoarchean strata of the 2.75-2.73 Ga. Confederation assemblage overlie these older assemblages. The contact between Balmer and Confederation, exposed in a number of localities, thus represents a 200 Ma time span. Both Meso- and Neoarchean sequences are intruded by diorite to granodiorite stocks such as the Dome stock which has been dated at 2718 +/- 1 Ma.

Balmer assemblage rocks host all of the major gold mines in the camp but it is important to note that 1.6 M. ounces of gold has been extracted from intrusive hosted deposits. The Balmer assemblage consists of mafic to ultramafic flows (including komatiites) and intrusives, minor felsic and interflow sedimentary rock types. Age dates from Balmer assemblage felsic rocks range from 2992 to 2964 Ma. (Corfu and Andrews, 1987).

Ball assemblage rocks underlie much of the western part of the district and consist of ultramafic to mafic flows, intermediate volcaniclastics and massive to spherulitic rhyolites.
Chemical sedimentary rocks (iron formations) also characterize Ball assemblage rocks and include stromatolites (Hofmann et al., 1985). The latter are bracketed by felsic rocks that are dated between 2940 Ma and 2925 Ma.

Bruce Channel assemblage rocks, as currently defined, are confined to the eastern part of the belt and comprise intermediate volcanioclastics and clastic rocks (2894 +/- 1.5 Ma). A distinctive magnetite bearing iron formation occurs at the top of the assemblage and forms a key marker horizon.

Confederation rocks comprise intermediate to felsic flows, volcanioclastic and metasedimentary rocks. Age dates for this assemblage range from 2748 +/- 15 Ma to 2733 +/- 1 Ma.

Granitoid rocks were intruded in three main episodes:

1. The 2734 +/- 2 Ma Douglas Lake pluton, the 2731 +/- 3 Ma (Little Vermilion Lake batholith) and 2729 +/- 1.5 Ma Red Crest stock.
2. The 2717 +/- 2 Ma Hammell Lake pluton, The McKenzie Island stock (2720 +/- 2 Ma), the Dome Stock 2718 +/- 1 Ma, the 2720 +/- 5 Ma Abino granodiorite and late QFP dykes at the Campbell Mine, dated at 2714 +/- 4 Ma.
3. Intrusion of the Killala Kspar megacrystic Killala-Baird granodiorite at 2704 +/- 1.5 Ma, the 2699 Walsh Lake pluton and a 2699 +/- 4 Ma dyke at the Madsen Mine.

Regional Structure

At least two major deformation events have affected the rocks of the belt resulting in the generation of type 2 interference fold structures on all scales. Overall strain in the belt is
low, however, local high strain zones do occur, typically in areas of strong alteration with locally associated gold mineralization. Previous workers identified five major shear or deformation zones within which major gold deposits of the camp occur. Recent work (Sandborn-Barrie et al., op. cit) has questioned the validity and usefulness of the deformation zone concept in the camp.

Metamorphism

Supracrustal rocks in the area have been regionally metamorphosed to greenschist facies with higher-grade contact metamorphic aureoles around the major felsic intrusions. No genetic or spatial relationship between regional metamorphic facies and gold deposition has been established.

Hydrothermal Alteration

A pervasive and often intense carbonate hydrothermal alteration event is superimposed on the deformation zones and appears to have had its greatest affect on mafic and ultramafic rocks. Primary minerals of the altered rocks have been converted to quartz, carbonate, epidote, plagioclase, chlorite and sericite (fuchsite and talc in the ultramafics).

Red Lake Gold Deposits

Gold occurs in the free state or with pyrite, pyrrhotite and arsenopyrite and lesser amounts of magnetite, chalcopyrite, sphalerite, galena and sulph-arsenides in quartz-ankerite and/or ‘cherty’ quartz veins, stockworks, lenses, stringers and silicified zones. In rare instances, scheelite is reported (Ferguson, 1966).
Silicification and carbonatization, together with very anomalous K-enrichment and Na + Ca (minor Mg)-depletion, occur in the alteration aureoles surrounding ore zones (Andrews and Wallace, op. cit.). One important aspect, particularly with respect to exploration, is the presence of geochemically elevated Au and As in the alteration aureoles (Durocher, 1983).

Andrews and Wallace (1983) point out that most of the productive areas of the Red Lake camp are underlain by tholeiitic to komatiitic mafic and ultramafic volcanics, and that past and present production zones occur within highly altered metavolcanics at or near the stratigraphic top of the Balmer sequence.

**Geophysical Interpretation Criteria – Red Lake Area Target:**

The geologic target for the Red Lake Area magnetic survey involves the identification of the Balmer sequence through potential mapping of mafic volcanics and metavolcanics and the location of structural breaks and/or areas of alteration within the key geologic environments. These structural breaks and alteration zones may appear as areas with reduced susceptibility due to silicification of otherwise strongly magnetized mafic and ultramafic units. For this survey, potential targets have been selected by attempting to identify these breaks and alteration zones on the basis of truncations and offsets in magnetic features, taken both from the measured vertical and horizontal gradients. Magnetic units and lineaments – weak magnetic trends that may represent lithological
contacts or structural breaks were identified independently of the geological data and should not be considered definitive.

In the interpretation of magnetic data, the anomaly wavelength is fundamentally related to the burial depth of the source. Attenuation caused by thickness of non-magnetic (air, water or sediment) is due almost entirely to the increase in distance between the sensor and the magnetic source. The rate of this magnetic attenuation depends upon both the type of body and the inverse square of the distance from source. Under special circumstances (i.e. where remanent magnetism developed during a period of reversed polarity and is retained within a large volume of material), magnetic units may actually subtract from the total field response. Anomalies generated by this process are thereby weaker in intensity or even negative in amplitude.

**Post Narrows Block**

There is a total magnetic variation across the survey block of close to 5420 nT. The total magnetic intensity grid is dominated by a series of linear magnetic units of varying magnetic susceptibilities. The distribution and orientation of these magnetic units provides a clear indicator of the predominant lithological and structural orientation within the survey area. The predominant orientation of magnetic units in the northern portion of the survey block is clearly NE-SW. The highly susceptible units in the southern part of the block show more complex folding. These may represent mafic to ultramafic units that sit within a structural setting that is more complex towards the south and the eastern portion of the block.
Two significant structural trends in the survey are defined in the magnetic data: a predominant ENE-WSW trend and a NW-SE trend which may be less well defined due to its orientation parallel to the flight lines. The former trend is seen crosscutting both the strongly susceptible units in the south and east as well as the less susceptible units to the north and west. The effect of this structure is creating breaks and offsets in the linear magnetic features and these are probably related to a significant regional structural trend which may provide a focus for further exploration.

A number of fold structures can be seen at locations such as at 444185E, 5660830N and 444010E, 5660040N and 445010E, 5662420N in the more susceptible units in the south and east and are indicative of the increasingly complex structural setting. These fold axes are subparallel to one another and trend approximately NE-SW, parallel to the predominant lithologic trend. This complex magnetic package may represent a magnetite-rich horizon, possibly iron formation or ultramafics. This package has also been intersected by a number of short discontinuous faults with orientations in the ENE-WSW orientation and examination of the vertical magnetic gradient shows evidence of minor movement along these fault zones.

In the north and west of the survey block can be seen a number of continuous magnetic units and magnetic “packages” that extend across the breadth of the survey area, as well as a number of smaller more discrete magnetic units that may represent possible intrusives. The magnetic susceptibilities in this area are generally lower than seen in the south east part of the survey area and may be arising from metasedimentary lithologies.
Recommendations:

Aeromagnetic interpretation is an ideal method of differentiating and defining magnetic terrains and establishing structural trends and major tectonic elements that contribute to an improved understanding of the geological setting within the survey area. Magnetic contours and their offsets and terminations were used to identify structural features such as faults and folds. Additional structural information can be derived from a more detailed evaluation of the magnetic data using, for example, shadowing techniques and calculation of higher order derivatives. Magnetic lineaments help to define the general “fabric” of an area and may also represent additional, less prominent, tectonic events. The delineation of these features could have important implications for future exploration. Integration of existing geological information, surface sampling results and further enhancement of the magnetic data through methods designed to highlight features that may be caused by geologic structure would ensure the best results from the ensuing follow-up work. The results from these processes should be reviewed with closer attention to the available and abundant regional and local geological, geochemical and geotechnical information to identify potential gold exploration target areas.

General Discussion

An helicopterborne magnetic survey over Post Narrows Block in the Red Lake area, Ontario has been flown on behalf of Rubicon Minerals Corporation. Fugro Airborne Surveys field operations in were carried out under the supervision of Darcy McGill,
Geophysicist. Data processing at the offices of Fugro Airborne Surveys in Mississauga, Ontario was done by Elizabeth Bowslaugh, Geophysicist, under the supervision of Emily Farquhar, Geophysicist and manager for Interpretation and Processing.

A total of 316.5 km including 285.8 km of traverse line and 30.7 km of tie line data has been flown. Coverage of the survey area is complete. The data is of good quality, with noise levels within contract specifications, and accurately represents the geophysical response of the Earth in the survey area.

The survey results are presented on 1 separate map sheet for each parameter at a scale of 1:10,000. The Geosoft format grids of the total magnetic intensity and measured vertical and horizontal gradient data are named with the product type (ex. MAG, CVG) and then the block name.

Respectfully submitted,

FUGRO AIRBORNE SURVEYS CORP.

Emily Farquhar M.Sc. Geophysics
Geophysicist

R2096-62002
REFERENCES


Ontario Geological Survey, 1991 - Geology and Gold Mineralization, Red Lake Greenstone Belt, OGS Map P310

APPENDIX A

LIST OF PERSONNEL

The following personnel were involved in the acquisition, processing, and presentation of data, relating to an airborne magnetic survey carried out for Rubicon Minerals Corporation, near Red Lake, Ontario.

David Miles Manager, Helicopter Operations
Emily Farquhar Manager, Data Processing and Interpretation
Michael Senko Senior Geophysical Operator
Darcy McGill Field Geophysicist
Terry Thomson Pilot
Elizabeth Bowslaugh Geophysical Dataprocessor
Lyn Vanderstarren Drafting Supervisor
Albina Tonello Secretary/Expeditor

The survey consisted of 316.5 km of coverage, flown from March 3 to March 11, 2002.

All personnel are employees of Fugro Airborne Surveys, except for the pilot who is on contract to Questral Helicopters.
APPENDIX B - BACKGROUND INFORMATION

Magnetics

Total field magnetics provides information on the magnetic properties of the earth materials in the survey area. The information can be used to locate magnetic bodies of direct interest for exploration, and for structural and lithological mapping.

The total field magnetic response reflects the abundance of magnetic material, in the source. Magnetite is the most common magnetic mineral. Other minerals such as ilmenite, pyrrhotite, franklinite, chromite, hematite, arsenopyrite, limonite and pyrite are also magnetic, but to a lesser extent than magnetite on average.

In some geological environments, an EM anomaly with magnetic correlation has a greater likelihood of being produced by sulphides than one that is non-magnetic. However, sulphide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Canada).

Iron ore deposits will be anomalously magnetic in comparison to surrounding rock due to the concentration of iron minerals such as magnetite, ilmenite and hematite.

Changes in magnetic susceptibility often allow rock units to be differentiated based on the total field magnetic response. Geophysical classifications may differ from geological classifications if various magnetite levels exist within one general geological classification.
Geometric considerations of the source such as shape, dip and depth, inclination of the earth’s field and remanent magnetization will complicate such an analysis.

In general, mafic lithologies contain more magnetite and are therefore more magnetic than many sediments which tend to be weakly magnetic. Metamorphism and alteration can also increase or decrease the magnetization of a rock unit.

Textural differences on a total field magnetic contour, colour or shadow map due to the frequency of activity of the magnetic parameter resulting from inhomogeneities in the distribution of magnetite within the rock, may define certain lithologies. For example, near surface volcanics may display highly complex contour patterns with little line-to-line correlation.

Rock units may be differentiated based on the plan shapes of their total field magnetic responses. Mafic intrusive plugs can appear as isolated "bulls-eye" anomalies. Granitic intrusives appear as sub-circular zones, and may have contrasting rings due to contact metamorphism. Generally, granitic terrain will lack a pronounced strike direction, although granite gneiss may display strike.

Linear north-south units are theoretically not well-defined on total field magnetic maps in equatorial regions due to the low inclination of the earth’s magnetic field. However, most stratigraphic units will have variations in composition along strike, which will cause the units to appear as a series of alternating magnetic highs and lows.
Faults and shear zones may be characterized by alteration, which causes destruction of magnetite (e.g., weathering) which produces a contrast with surrounding rock. Structural breaks may be filled by magnetite-rich, fracture filling material as is the case with diabase dikes, or by non-magnetic felsic material.

Faulting can also be identified by patterns in the magnetic total field contours or colours. Faults and dikes tend to appear as lineaments and often have strike lengths of several kilometres. Offsets in narrow, magnetic, stratigraphic trends also delineate structure. Sharp contrasts in magnetic lithologies may arise due to large displacements along strike-slip or dip-slip faults.
APPENDIX C

The coordinate system for all grids and XYZ files is projected as follows

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datum</td>
<td>NAD83</td>
</tr>
<tr>
<td>Local Transformation</td>
<td>none</td>
</tr>
<tr>
<td>Spheroid</td>
<td>GRS80</td>
</tr>
<tr>
<td>Projection</td>
<td>UTM</td>
</tr>
<tr>
<td>Central meridian</td>
<td>93 West</td>
</tr>
<tr>
<td>False easting</td>
<td>0</td>
</tr>
<tr>
<td>False northing</td>
<td>500000</td>
</tr>
<tr>
<td>Scale factor</td>
<td>0.9996</td>
</tr>
<tr>
<td>Northern parallel</td>
<td>N/A</td>
</tr>
<tr>
<td>Base parallel</td>
<td>N/A</td>
</tr>
<tr>
<td>WGS84 to local conversion method</td>
<td>Molodensky</td>
</tr>
<tr>
<td>Delta X shift</td>
<td>0</td>
</tr>
<tr>
<td>Delta Y shift</td>
<td>0</td>
</tr>
<tr>
<td>Delta Z shift</td>
<td>0</td>
</tr>
</tbody>
</table>

If you have any problems with this archive please contact

Processing Manager
FUGRO AIRBORNE SURVEYS LTD.
2270 Argentia Road
Mississauga, Ontario
Canada L5N 6A6
Tel (905) 812-0212
Fax (905) 812-1504
E-mail toronto@fugroairborne.com
Maps contain blackline contours of the total magnetic field in combination with the flight path, planimetric information, UTM registration and claim boundaries. Maps are presented in two copies.
# Work Report Summary

**Transaction No:** W0220.01377  
**Status:** APPROVED  
**Recording Date:** 2002-AUG-28  
**Work Done from:** 2002-MAR-03 to: 2002-MAR-11  

**Client(s):**  
129617 ENGLISH, PERRY VERN  
301254 RUBICON MINERALS CORPORATION  

**Survey Type(s):** AMAG  

## Work Report Details:  

<table>
<thead>
<tr>
<th>Claim#</th>
<th>Perform Approve</th>
<th>Applied Approve</th>
<th>Assign Approve</th>
<th>Reserve</th>
<th>Reserve Approve</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>KRL 1022728</td>
<td>$58</td>
<td>$58</td>
<td>$0</td>
<td>$58</td>
<td>58</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1022729</td>
<td>$107</td>
<td>$107</td>
<td>$0</td>
<td>$107</td>
<td>107</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1022732</td>
<td>$131</td>
<td>$131</td>
<td>$0</td>
<td>$131</td>
<td>131</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1022734</td>
<td>$103</td>
<td>$103</td>
<td>$0</td>
<td>$103</td>
<td>103</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1022735</td>
<td>$231</td>
<td>$231</td>
<td>$0</td>
<td>$231</td>
<td></td>
<td>$231</td>
</tr>
<tr>
<td>KRL 1022736</td>
<td>$75</td>
<td>$75</td>
<td>$0</td>
<td>$75</td>
<td>75</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1022737</td>
<td>$215</td>
<td>$215</td>
<td>$0</td>
<td>$151</td>
<td>151</td>
<td>$64</td>
</tr>
<tr>
<td>KRL 1022738</td>
<td>$175</td>
<td>$175</td>
<td>$0</td>
<td>$175</td>
<td>175</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1231807</td>
<td>$1,165</td>
<td>$1,165</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$1,165</td>
</tr>
<tr>
<td>KRL 1231808</td>
<td>$346</td>
<td>$346</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$346</td>
</tr>
<tr>
<td>KRL 1231809</td>
<td>$1,504</td>
<td>$1,504</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$1,504</td>
</tr>
<tr>
<td>KRL 1231811</td>
<td>$691</td>
<td>$691</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$691</td>
</tr>
<tr>
<td>KRL 1231863</td>
<td>$1,076</td>
<td>$1,076</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
<td>$1,076</td>
</tr>
<tr>
<td>KRL 1234549</td>
<td>$0</td>
<td>$400</td>
<td>$400</td>
<td>$0</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>KRL 1234550</td>
<td>$0</td>
<td>$400</td>
<td>$400</td>
<td>$0</td>
<td>0</td>
<td>$0</td>
</tr>
</tbody>
</table>

| Total Remaining | $5,077 | 0 |

**External Credits:**

| $0 |

**Status of claim is based on information currently on record.**
Dear Sir or Madam

Submission Number: 2.24128  
Transaction Number(s): W0220.01377

Subject: Approval of Assessment Work

We have approved your Assessment Work Submission with the above noted Transaction Number(s). The attached Work Report Summary indicates the results of the approval.

At the discretion of the Ministry, the assessment work performed on the mining lands noted in this work report may be subject to inspection and/or investigation at any time.

If you have any question regarding this correspondence, please contact BRUCE GATES by email at bruce.gates@ndm.gov.on.ca or by phone at (705) 670-5856.

Yours Sincerely,

Richard Gashinski  
Senior Manager, Mining Lands Section

Cc: Resident Geologist  
Assessment File Library

Perry Vern English  
Perry Vern English
(Claim Holder)  
(Assessment Office)

Rubicon Minerals Corporation  
(Claim Holder)