Orthorectification & Pansharpening of Quickbird Satellite Image

On

TRES-OR RESOURCES and ADROIT RESOURCES INC

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JUN 16 2005
GEOSCIENCE ASSESSMENT OFFICE

COBALT SOUTH PROPERTY

Gillies Limit, Lorrain and South Lorrain Townships

Larder Lake Mining Division

PROVINCIAL RECORDING OFFICE - SUDBURY
RECEIVED
JUN 16 2005 Courier.
A.M. SW. 9:40 P.M.
7|8|9|10|11|12|1|2|3|4|5|6

UTM Zone 17 - NAD 83 Projection
5228000N to 5239000N UTM
597000E to 608000E UTM

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Hinterland Geoscience & Geomatics

For:
Tres-Or Resources Ltd. and Adroit Resources Inc.

June 5th, 2005

Introduction

Since the successful launch of DigitalGlobe's QuickBird satellite and the availability of the data, QuickBird imagery has quickly become a popular choice for large-scale mapping using high-resolution satellites. First, the satellite has panchromatic and multispectral sensors with resolutions of 61-72cm and 2.44-2.88m, respectively, depending upon the off-nadir viewing angle (0-25 degrees). The sensor therefore has a coverage of 16.5-19km in the across-track direction. In addition, the alongtrack and across-track capabilities provide a good stereo geometry and a high revisit frequency of 1-3.5 days. Finally, the data is available in different formats, including the raw data format (Basic Imagery), which preserves the satellite geometry and is preferred by the photogrammetry and mapping community to achieve high accuracy geometric correction and geospatial products.

This report, we will describe the followings: (1) the correction of QuickBird data using different geometric correction methods, (2) data fusion using QuickBird panchromatic and multispectral data.

Orthorectification of Quickbird Imagery over the Cobalt South Project.

Several full Quickbird scene (16.5 km x 16.5 km) were acquired over Aquired Over the Cobalt-South Project on June 13, 2004 to evaluate landform and landuse and correlate information to the Helicopter-Born magnetic and electromagnetic survey by Aeroquest Ltd. A "*Standard Ortho Ready Kit*" was purchased which contains the necessary information (ephemeris data) to be imported into PCI OrthoEngine. The following questions were at the heart of this work:

- Can Quickbird imagery be potentially used as a replacement for orthophotos created from traditional high-resolution aerial photography?
- How easily can an image be orthorectified?
- How accurate does ground control need to be for orthorectification?
- What type of DEM is needed to orthorectify a scene?

What are the issues with orthorectifying images in remote locations with poor ground control and bad DEMs? • What are RPCs and what are their advantages / disadvantages compared to using a rigorous math model?

Orthorectification Methodology

Recent advances in satellite remote sensing have made it possible to easily generate accurate orthorectified imagery. This has been made possible by the inclusion of satellite ephemeris data (information about the position of the satellite at the time the image was acquired) in the satellite image product and the availability of commercial

orthorectification software. To orthorectify an image it is only necessary that the user have the following:
• Image data with ephemeris data.
• Orthorectification software.
• Good ground control data, usually gathered from existing orthophotos or collected with a gps.
• An accurate DEM.

Collection of Ground Control Points (GCPs)

For this study ground control points where collected by two different methods:
• Differential GPS
• Image-to-Image registration using Aster and Landsat7 data. The collection of very accurate ground control is very important in the orthorectification process. To obtain the best accuracy for orthorectification it is best to collect GCPs at accuracies greater than the pixel resolution if the imagery (sub-pixel accuracy). Because the Quickbird panchromatic band has a resolution of 60 cm it was necessary to collect ground control points using a gps that had the capability of collecting data in a form that could be post processed to give sub-meter accuracy. All data was collected in "Carrier Phase Mode" and post processed using the ground base station. Overall, gps points were consistently post processed to 60-90 cm accuracy. It is important to realize that collecting accurate gps points is time intensive and is a considerable portion of the overall cost in producing an orthorectified image. A minimum of a ½ hour is required for collecting a point and may take upwards of an hour. A minimum of 10-15 GCPs needs to be collected per scene and it is best that most of the GCPs are evenly distributed across the image. It is also important that the GCPs are collected at a variety of elevations and it is optimal if there are GCPs that are collected near the minimum and maximum elevation of the image area. Depending on how rugged an image area is and the availability of road access, it will take 3-5 days to collect sufficient GCPs if a highly accurate orthorectified product is required. The goal was to try and produce an orthorectified image with 2 meter or less spatial accuracy. The first step was to collect ground control points (GCPs). Collecting GPS points around well-defined objects did this. The ground objects needed to have distinct edges that can be seen on the image and a shape that would allow for precise GCP placement on the raw imagery.
For example, the following would be good features:
• Driveways or trail intersection
• Big, bright rock boulders.
• cabins.
• recognizable features

Data Fusion

The availability of a 0.6m panchromatic band, in conjunction with 2.4m VIR bands, affords the opportunity to fuse panchromatic and VIR data to create an effective 0.6m

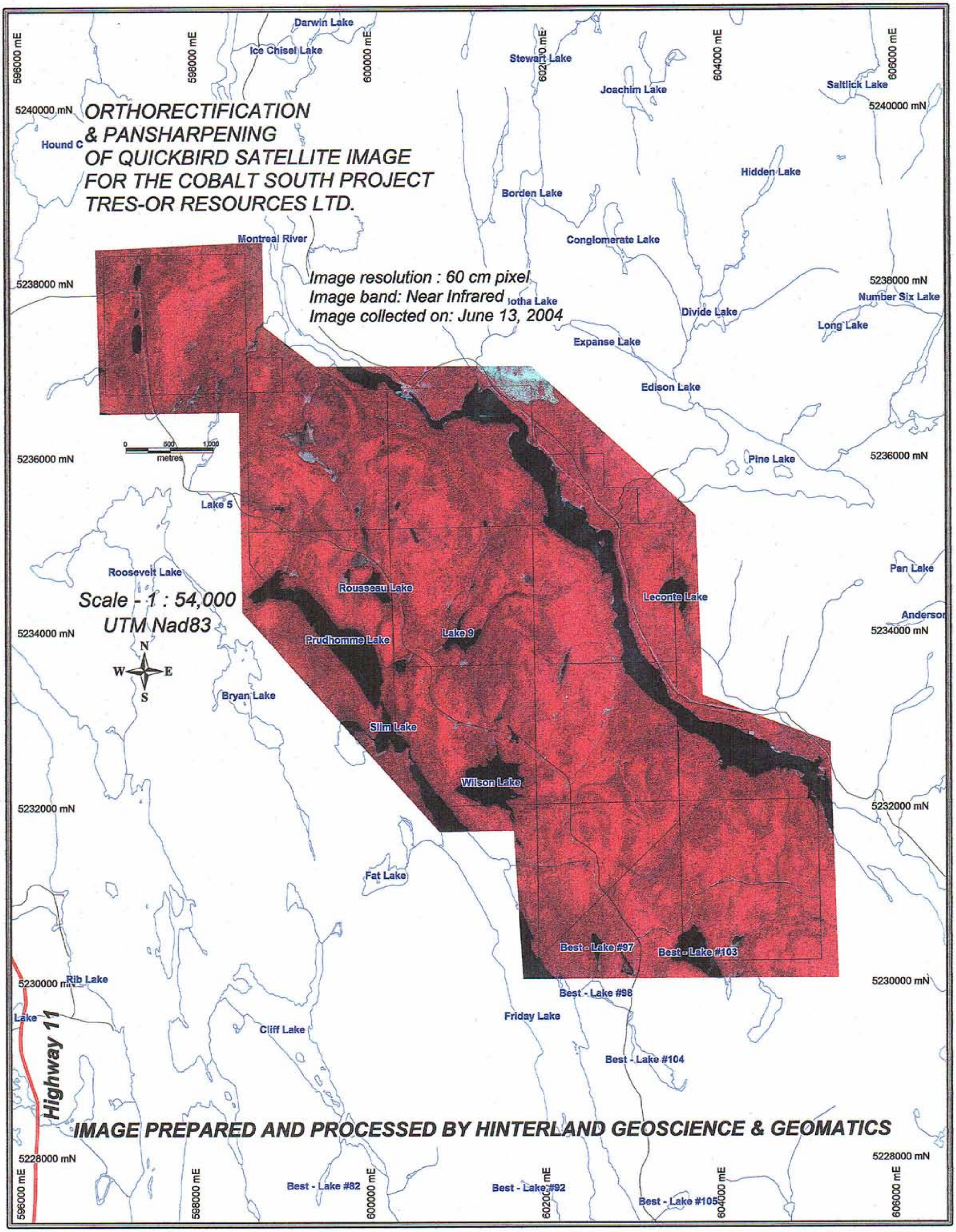
VIR pan-sharpened image. Image fusion is an important technique for a variety of remote sensing applications. Most earth resource satellites, such as the SPOT, IRS, Landsat 7, IKONOS, QuickBird and Orbview provide both multispectral images at a lower spatial resolution and panchromatic images at a higher spatial resolution. However, existing techniques can hardly satisfy the fusion of multispectral and panchromatic images from the new satellites such as IKONOS, QuickBird, and Landsat 7 and Orbview.

Based on thorough studies and analyses of existing fusion algorithms and their fusion effects, a new automatic fusion approach has been developed by the Dr. Yun Zhang at the University of New Brunswick, Canada. This new technique solved the two major problems in image fusion – colour distortion and operator dependency. A method based on least squares was employed for a best approximation of the grey value relationship between the original multispectral, panchromatic and the fused image bands for a best colour representation. Statistic approaches were applied to the fusion for standardizing and automating the fusion process. The new fusion approach has been extensively applied to the fusion of different IKONOS, QuickBird and Landsat 7 multispectral and panchromatic image bands. All the multispectral bands of a satellite can be fused with the corresponding panchromatic band at one time, resulting in optimal fusion result with minimized colour distortion, maximized feature detail, and natural integration of colour and spatial feature from multispectral and panchromatic bands. The algorithm is now included in the PCI Geomatics software.

CONCLUSIONS

A critical factor in the orthorectification process is the GPS field campaign, with which we can achieve a much more higher accuracy than the magnitude imposed by the size of the quickbird pixel (60 cm). The skill of the operator though is of critical importance, which is also influencing the accuracy of the solution, because of the difficulty in properly selecting the correct pixel within the rugged environment.

If both panchromatic and multispectral images are available, the fusion of panchromatic and multispectral images can be performed using a new fusion technique developed by Dr. Zhang at the University of New Brunswick, Canada. The resulting fused image displays sharp features from the panchromatic image while preserving the colour from the multispectral image. This proved to be very enlightening when compare and integrated with the Helicopter-Born magnetic and electromagnetic survey.



ORTHORECTIFICATION
& PANSHARPENING
OF QUICKBIRD SATELLITE IMAGE
FOR THE COBALT SOUTH PROJECT
TRES-OR RESOURCES LTD.
Image resolution : 60 cm pixel
Image band: Near Infrared
Image collected on: June 13, 2004
Scale - 1 : 54,000
UTM Nad83
N
W
E
S
0
500
1,000
metres
596000 mE
598000 mE
600000 mE
602000 mE
604000 mE
606000 mE
5240000 mN
5238000 mN
5236000 mN
5234000 mN
5232000 mN
5230000 mN
5228000 mN
Darwin Lake
Ice Chisel Lake
Stewart Lake
Joachim Lake
Saltlick Lake
Hound C
Hidden Lake
Borden Lake
Montreal River
Conglomerate Lake
Iotha Lake
Divide Lake
Number Six Lake
Long Lake
Expanse Lake
Edison Lake
Pine Lake
Lake 5
Roosevelt Lake
Rousseau Lake
Leconte Lake
Pan Lake
Anderson
Prudhomme Lake
Lake 9
Bryan Lake
Slim Lake
Wilson Lake
Fat Lake
Best - Lake #97
Best - Lake #103
Rib Lake
Lake
Best - Lake #98
Friday Lake
Cliff Lake
Best - Lake #104
Highway 11
IMAGE PREPARED AND PROCESSED BY HINTERLAND GEOSCIENCE & GEOMATICS
Best - Lake #82
Best - Lake #92
Best - Lake #105

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RESULT AND INTERPRETATION

QuickBird's high resolution, high revisit frequency, large area coverage, and the ability to take images over any area, especially difficult areas where airplanes have difficulty to fly, are certainly the major advantages over the use of aerial photos.

Four Hydroelectric power stations are in the vicinity of the Cobalt South Project. Many high voltage power lines crisscross the area and make it tricky for airplanes. In addition, high-resolution digital terrain model DTM can be extracted automatically from the stereo data. The high resolution DTM can help in areas such as determination of escarpment heights, prediction of water movement, and identification of small swamp or humid bodies or vegetation. The potential uses for QuickBird imagery are only limited by users imagination.

The panchromatic, natural color, and color infrared (Fig. A) versions of standard imagery are well suited for visual analysis and as a backdrop for GIS and mapping applications.

Two-dozen Kimberlite targets were identified on the Helicopter-Born magnetic, but only half of them were kept after been reviewed with the satellite image. An in-depth lineation study should be undertaken to understand the complex nature of this terrain. Several narrow linear magnetic highs trending northwest are clearly visible on the magnetic data, but crosscuts most of the topography with no or little surface expression. Meanwhile, strong appearing topographic lineaments are clearly visible on the imagery, but not reflected in the magnetic or EM responses.

The Quickbird imagery was also successful in mapping the large oblate magnetic highs to the surface expression.

Figure A. GIS comparison of the Quickbird satellite image and the Helicopter-Born Total Field Magnetic data. Topographic contours, Kimberlite targets, and claim fabric overlie both images.

COLOUR INFRARED PANSHARPED QUICKBIRD
OVERLAIN BY ELEVATION CONTOUR CLAIM BOUNDARIE AND TARGETS

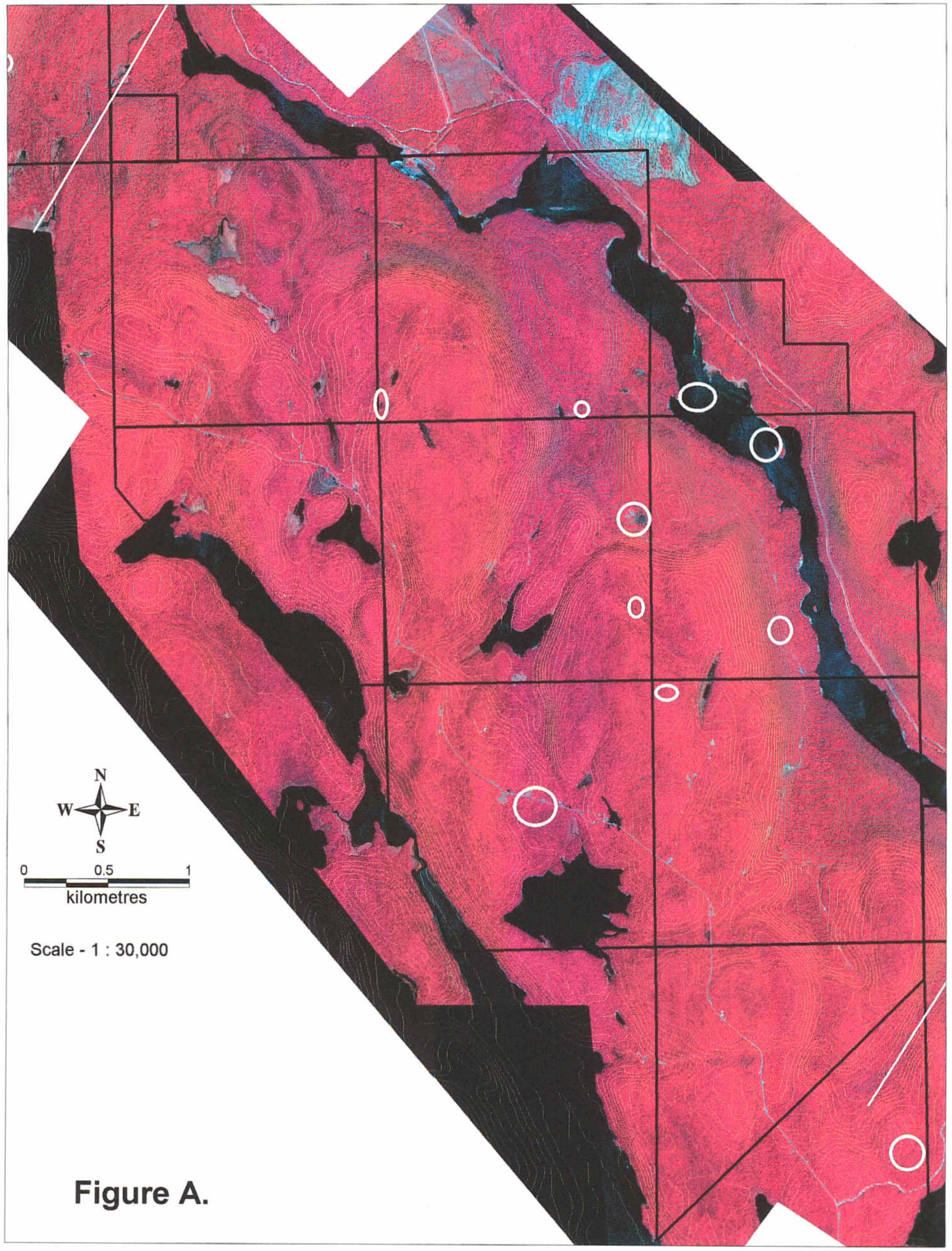

Figure A.

HELI-BORN TOTAL FIELD MAGNETIC DATA
OVERLAIN BY ELEVATION CONTOUR CLAIM BOUNDARIE AND TARGETS

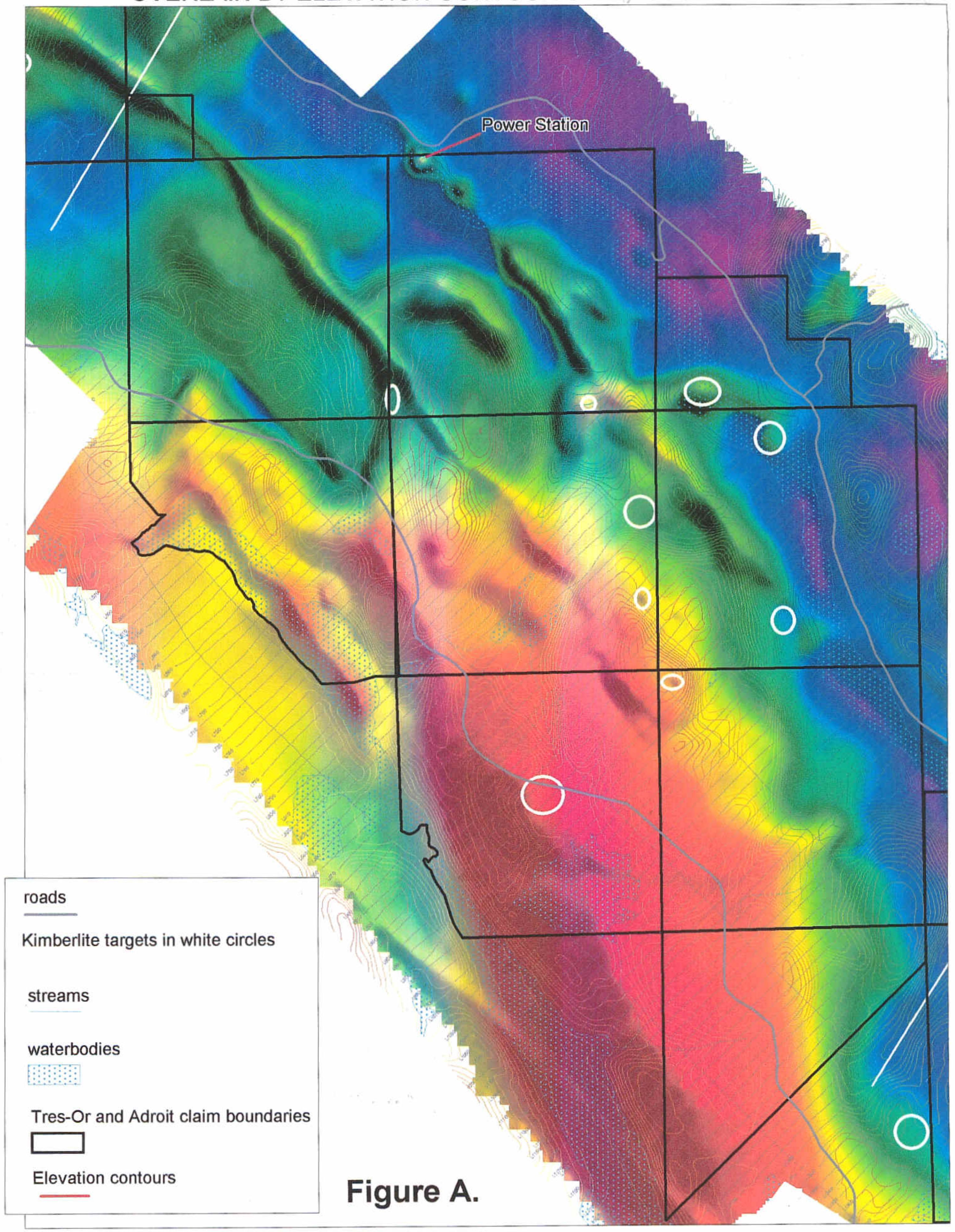

Figure A.