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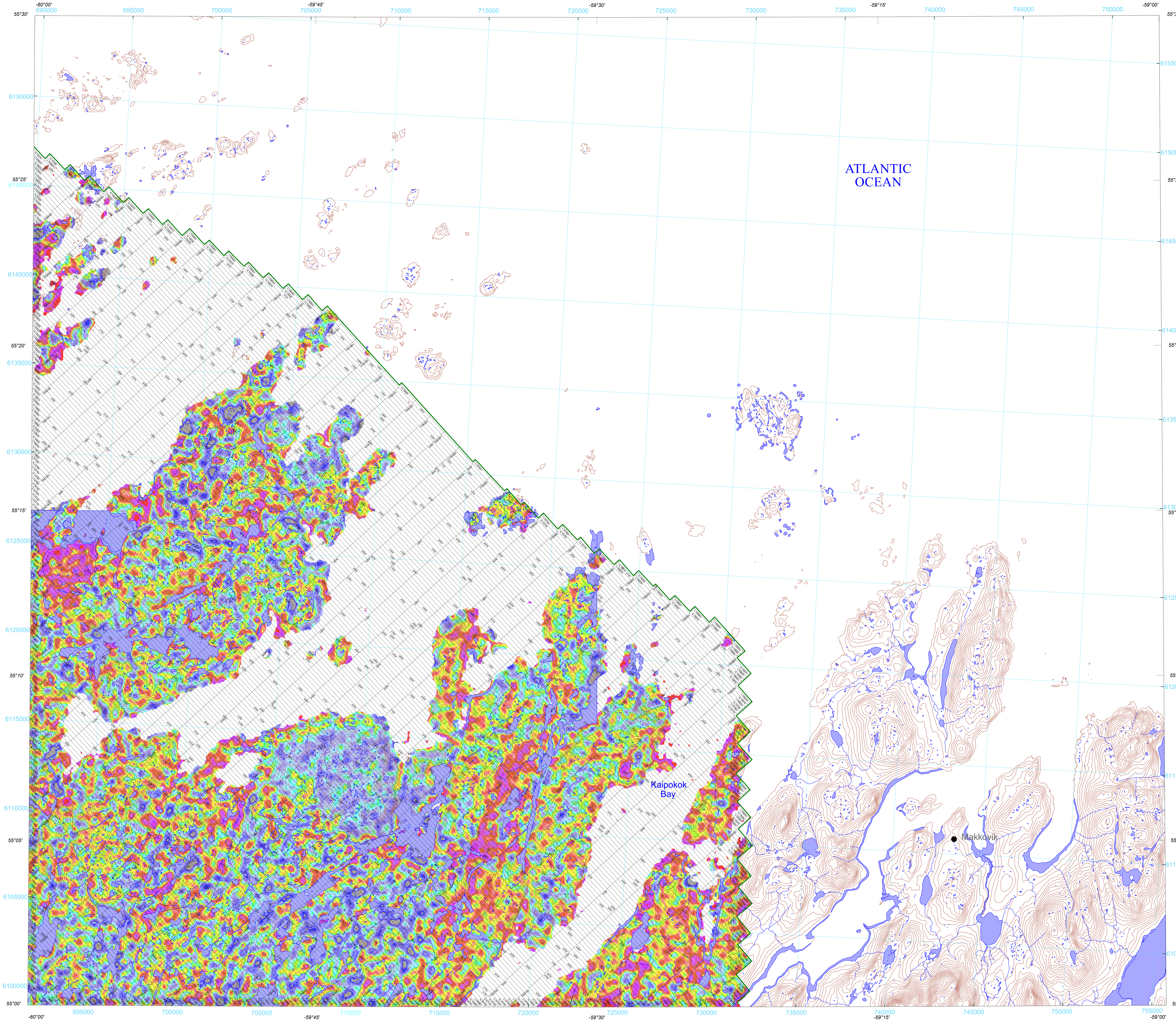
Newfoundland Labrador
Industry, Energy and Technology

URANIUM/THORIUM RATIO



Introduction

A quantitative gamma-ray spectrometric and aeromagnetic airborne geophysical survey of the Makkovik River West area, Newfoundland and Labrador, was completed by Geo Data Solutions GDS Inc. The survey was flown from August 1st to October 3rd, 2022, using three Piper PA-31 Navajo aircraft (C-GPTB, C-FVYW, C-FVTL) and a Beechcraft King Air 100 (C-FLRB). The nominal traverse and control line spacings were, respectively, 200 m and 1200 m, and the aircraft flew at a nominal terrain clearance of 80 m at an average airspeed of 269 km/h. Traverse lines were oriented N45°W with orthogonal control lines. The flight path was recovered following post-flight differential corrections to raw data recorded by a Global Positioning System. The survey was flown on a pre-determined flight surface to minimize differences in magnetic values at the intersections of control and traverse lines.

Gamma-ray Spectrometric Data

The airborne gamma-ray measurements were made with a Radiation Solutions RS-500 gamma-ray spectrometer using ten 102x102x406 mm NaI (Tl) crystals. The main detector array consisted of eight crystals (total volume 33.6 litres). Two crystals (total volume 8.4 litres), shielded by the main array, were used to detect variations in background radiation caused by atmospheric radon. The system assembles 1024 channel spectra from the individual NaI (Tl) detectors with no loss of Poisson statistics. Spectrum stabilization is accomplished by matching the recorded spectra with several natural gamma-ray peaks.

Potassium is measured directly from the 1460 keV gamma-ray photons emitted by ^{40}K whereas uranium and thorium are measured indirectly from gamma-ray photons emitted by daughter products (^{214}Bi for uranium and ^{208}Tl for thorium). Although these daughters are far down their respective decay chains, they are assumed to be in equilibrium with their parents; thus gamma-ray spectrometric measurements of uranium and thorium are referred to as equivalent uranium and equivalent thorium, i.e., eU and eTh. The energy windows used to measure potassium, uranium and thorium are, respectively, 1370-1570 keV, 1660-1860 keV, and 2410-2810 keV.

Gamma-ray spectra were recorded at one-second intervals. Data processing followed standard procedures as described in IAEA, 1991 and IAEA, 2003. During processing, the spectra were energy calibrated, and counts were accumulated into the windows described above. Counts from the radon detectors were recorded in a 1660 - 1860 keV window and radiation at energies greater than 3000 keV was recorded in the cosmic window. The window counts were corrected for dead time, background activity from cosmic radiation, radioactivity of the aircraft, and atmospheric radon decay products. The window data were then corrected for spectral scattering in the ground, air, and detectors. Corrections for deviations from the planned terrain clearance and for variation of temperature and pressure were made prior to conversion to ground concentrations of potassium, uranium, and thorium, using factors determined from flights over the Breckenridge test strip. The factors for potassium, uranium, and thorium are listed in Table 1.

	C-GPTB	C-FVYW	C-FVTL	C-FLRB
Potassium (cps/%)	50.49	43.68	47.84	43.53
Uranium (cps/ppm)	5.23	5.21	6.04	5.98
Thorium (cps/ppm)	3.34	2.93	3.28	2.92

Table 1 Gamma Ray Spectrometric Sensitivities for each aircraft.

Corrected data were filtered and interpolated to a 50 m grid interval. A ternary colour-composite image was created in which the relative concentrations of potassium, equivalent uranium, and equivalent thorium determined the colour hue, and the total radioactivity determined the colour saturation (Broome et al., 1987). Data points that were acquired over water bodies or where the effective height above ground was higher than 300 m were masked out in the map due to their poor acquisition statistics and possible terrain effect. The results of an airborne gamma-ray spectrometer survey represent the average surface concentrations of the three natural radioelements, and are influenced by nature of overburden, presence of outcrops, vegetation cover, soil moisture, and surface water. As a result, the measured concentrations are usually lower than the actual bedrock concentrations. The total air absorbed dose rate in nanograys per hour was produced from measured counts between 400 and 2810 keV.

Magnetic Data

The magnetic field was sampled 10 times per second using a split-beam cesium vapour magnetometer (sensitivity = 0.005 nT) rigidly mounted to the aircraft. Differences in magnetic values at the intersections of control and traverse lines were analysed to obtain a mutually levelled set of flight-line magnetic data. The levelled values were then interpolated to a 50 m grid. The International Geomagnetic Reference Field (IGRF) defined at the average GPS altitude of 348 m for the year 2022.7 was then removed. Removal of the IGRF, representing the magnetic field of the Earth's core, produces a residual component related essentially to magnetizations within the Earth's crust.

The first vertical derivative of the magnetic field is the rate of change of the magnetic field in the vertical direction. Computation of the first vertical derivative removes long-wavelength features of the magnetic field and significantly improves the resolution of closely spaced and superposed anomalies. A property of first vertical derivative maps is the coincidence of the zero-value contour with vertical contacts of magnetic units at high magnetic latitudes (Hood, 1965).

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/). Corresponding digital profile and gridded data as well as similar data for adjacent airborne geophysical surveys are available from Natural Resources Canada's Geoscience Data Repository for Aeromagnetic data at https://geophysical-data.canada.ca/. Digital products from this airborne survey are also available from the GSNL Geoscience Atlas at https://geoatlas.gov.nl.ca/Default.htm.

References

Hood, P.J., 1965. Gradient measurements in aeromagnetic surveying. Geophysics, 30, 891-902.

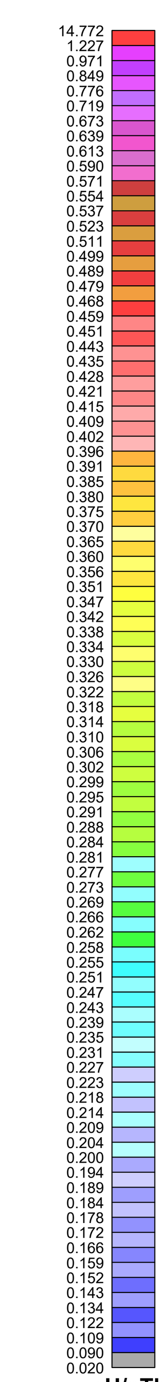
Broome, J., Carson, J.M., Grant, J.A., and Ford, K.L., 1987. A modified ternary radioelement mapping technique and its application to the south coast of Newfoundland. Paper 87-14, Geological survey of Canada, Ottawa, Ontario, Canada.

International Atomic Energy Agency, 1991. Airborne gamma ray spectrometer surveying. Technical Reports Series 323, IAEA, Vienna.

International Atomic Energy Agency, 2003. Guidelines for radioelement mapping using gamma ray spectrometry data. Technical Reports Series 363, IAEA, Vienna.

OPEN FILE MAP INDEX

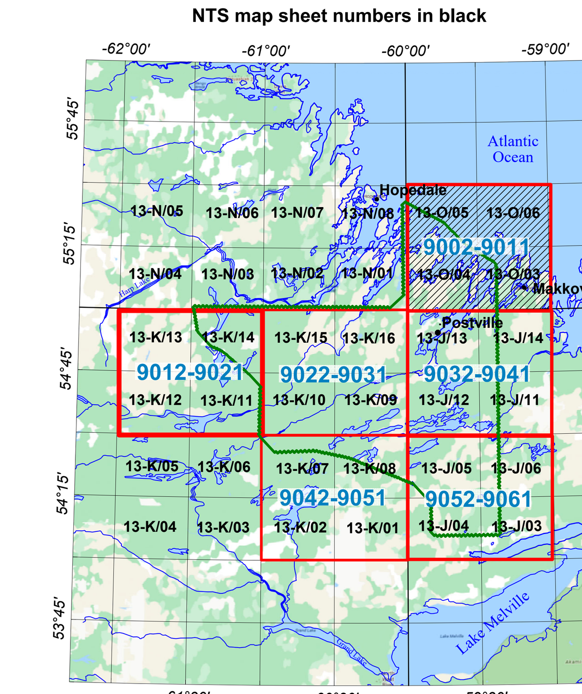
OF9002: Residual Total Magnetic Field
OF9003: First Vertical Derivative of the Magnetic Field
OF9004: Natural Air Absorbed Dose Rate
OF9005: Potassium
OF9006: Uranium
OF9007: Thorium
OF9008: Uranium / Thorium
OF9009: Uranium / Potassium
OF9010: Thorium / Potassium
OF9011: Ternary Radioelement Image



PLANIMETRIC SYMBOLS

Project Limit ....
Drainage ....
Topographic Contour ....
Flight Path .... L12370>

GSC open file numbers in blue
NTS map sheet numbers in black



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND GEOPHYSICAL MAP INDEX

AIRBORNE GEOPHYSICAL SURVEY OF THE MAKKOVIK RIVER WEST AREA

GEOLOGICAL SURVEY OF CANADA OPEN FILE 9008

NEWFOUNDLAND AND LABRADOR DEPARTMENT OF INDUSTRY, ENERGY AND TECHNOLOGY, GEOLOGICAL SURVEY OPEN FILE LAB/1782, MAP 2023-40

URANIUM/THORIUM RATIO

AIRBORNE GEOPHYSICAL SURVEY OF THE MAKKOVIK RIVER WEST AREA

NEWFOUNDLAND AND LABRADOR
NTS 13-O/Southwest

Authors: M. Coyle and R. Fortin

Data acquisition and data compilation by Geo Data Solutions (GDS) Inc., Laval, Quebec

Contract and project management by the Geological Survey of Canada, Ottawa, Ontario

Permanent link: https://doi.org/10.4095/332204

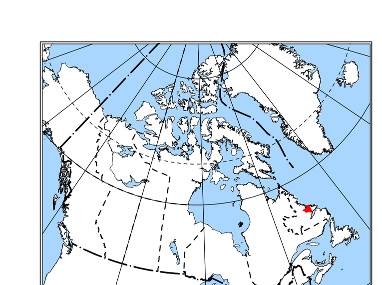
Scale 1:100 000

2 0 2 4 6 (kilometres)

Universal Transverse Mercator Projection
North American Datum 1983

Base map at the scale of 1:250 000 from Natural Resources Canada, with modifications
Elevations in metres above sea level

This airborne geophysical survey and the production of this map were funded by the GEM-GeoNorth program of the Geological Survey of Canada, Lands and Minerals Sector, Natural Resources Canada.



MAP LOCATION

OPEN FILE
DOSSIER PUBLIC
9008
GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
2023

Publications in this series have not been edited; they are released as submitted by the author.

Les publications de cette série ne sont pas révisées; elles sont publiées telles que soumises par l'auteur.

Newfoundland and Labrador
Department of Industry, Energy and Technology
Geological Survey Open File
LAB/1782, Map 2023-40

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