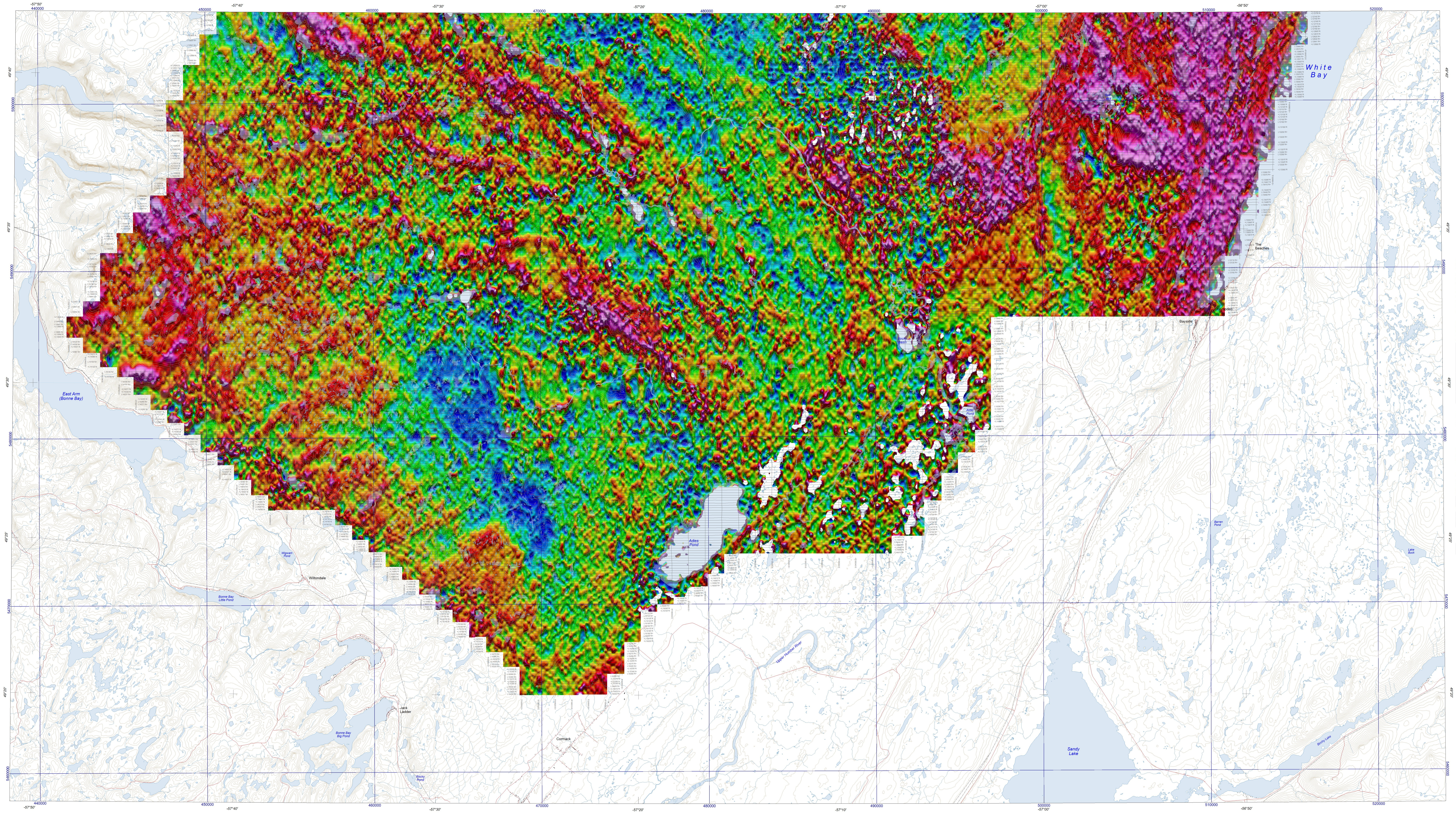

Newfoundland & Labrador
Energy and Mines

AIRBORNE GEOPHYSICAL SURVEY OF THE WHITE BAY WEST AREA, WESTERN NEWFOUNDLAND

Map Sheet 2 - Parts of NTS
12H/05,06,10,11,12

RATIO OF EQUIVALENT THORIUM TO POTASSIUM

Open File NFLD/3556, Map 2026-31
Map 16 of 26

G.J. Kilfoil

ABOUT THE SURVEY

Survey Details

This aeromagnetic gradient, gamma-ray spectrometric, and VLF-EM airborne geophysical survey of the White Bay West region, Newfoundland, was flown by Terraquest Airborne Geophysics Limited. Acquisition commenced on October 14th, 2024, weather forced a hiatus November 25th with the remainder of the survey anticipated to be completed during the summer of 2025. The survey aircraft used for this survey is a Piper Panther Navajo PA31-325 (C-FWNE).

The hiatus ended with the arrival of a Piper Navajo C PA31 (C-GYYP) on July 9th, 2025. However, this aircraft was out of service on July 26th, 2025. Survey aircraft Cessna 206u Super Sky Wagon (C-GGLS) completed the remaining Tie Lines on August 25th, 2025, without a gamma-ray spectrometer. A Piper Panther Navajo PA31-325 (C-FWNE) resumed survey operations on October 6th, 2025, but without a VLF-EM receiver. A portion of the survey area was sub-contracted to Sanborn Geospatial using a Cessna Grand Caravan 208B (N29MG) which arrived October 25th, 2025. This aircraft did not have VLF-EM capability installed. All aircraft were removed December 14th, 2025, due to poor weather and a contractual deadline. By this date, a total of 93.16% of the originally planned survey was flown; 30192.96 of the planned 32408.1 line-km were acquired with 2215.16 line-km outstanding.

The nominal traverse and control line spacings were 150 m and 1000 m respectively and each aircraft flew at a mean terrain clearance of 151.8 m at a mean speed of 87.7 m/s. Traverse lines were oriented 0° with orthogonal (90°) control lines. The fight path was recovered using a real-time differential GPS navigation system. Terraquest uses a DAARC500 (RMS Instruments Inc.) for magnetic compensation and data acquisition.

Gamma-ray Spectrometer Data

The airborne gamma-ray measurements were made using gamma-ray spectrometers, with RS-501 and RSX-5 systems from Radiation Solutions Inc., as well as the AGRS from Sanborn. Both systems included the downward detector of 33.6 L (8 NaI crystals) and an upward detector of 8.4 L (2 NaI crystals). The upward detector was used to detect variations in background radiation caused by atmospheric radon and was positioned such that it was shielded by the downward crystal array. Each crystal was individually gain stabilized using a sophisticated multi-peak approach, effectively eliminating the need for any pre-stabilization with external sources (although Terraquest will continue to use external sources).

Potassium is measured directly from the 1460 keV gamma-ray photons emitted by potassium-40 (^{40}K), whereas uranium and thorium are measured indirectly from gamma-ray photons emitted by daughter products, bismuth-214 (^{214}Bi) for uranium and thallium-208 (^{208}Tl) for thorium. These daughter products 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: 1370-1570 keV, 1660-1860 keV and 2410-2810 keV, respectivey.

Gamma-ray spectra were acquired 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 as 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 background activity from cosmic radiation, radioactively 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 variations of temperature and pressure were made prior to conversion to ground concentrations of potassium, uranium and thorium, using factors determined from calibration flights over the Breckenridge, Ontario calibration range.

Results of this airborne gamma-ray spectrometer survey represent the average surface concentrations in the region. These results are influenced by overburden, vegetation cover, soil moisture and surface water. As a result, the measured concentrations are typically lower than the actual concentrations in the survey area.

Magnetic Data

The measured magnetic field was sampled 10 times per second using three split-beam cesium vapor magnetometers (Scintrex CS-3) mounted inside two wingtip pods and a tail boom mounted on each aircraft. This 3-sensor array forms a horizontal magnetic gradiometer. By knowing the precise location of the three magnetic sensors in space, the In-Line and Cross-Line gradients can be accurately determined. The gradient calculation can be extended to produce the East-West and North-South gradients referenced to geographic North. Furthermore, a Reconstructed Total Field (RTF) has been calculated directly from the horizontal gradient data using a method described by Nelson (1994).

The tail magnetometer is used to produce a Total Magnetic Intensity (TMI). For the TMI, the data are lag corrected, and, statistically levelled using the differences in magnetic values at the intersections of traverse and tie lines. The International Geomagnetic Reference Field (IGRF) defined at the average elevation of 403 m for the date January 1st 2025 was then removed for the statistically levelled corrected magnetic data (RMI). Removal of the IGRF representing the magnetic field of the Earth's core, yields 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 superimposed anomalies (Hood, 1965). Similar to the first vertical derivative, the analytic signal of the total magnetic intensity is calculated to highlight regional gradients in the data and to help resolve overlapping anomalies (Miller and Singh, 1984). The tilt derivative is also calculated, which can help identify structural features present in the shallow bedrock geology.

VLF-EM Data

Very low frequency (VLF) electro-magnetic data were measured Matrix-*Plus*™ VLF-EM receiver mounted in the tail boom of the aircraft. The VLF stations monitored during survey are selected prior to the start of survey flying based on expected station availability and accessible signal. However, not all stations monitored provide usable signal. Generally, the quality of the signal is dictated by the transmitter source power and its distance from the survey area. Furthermore, as with all Electromagnetic (EM) wave propagation, the quality and/or power of the signal may also be degraded further by the natural earth features between the transmitter source and the receiver. For this survey, only the signal from Culter, Maine (NAA, 24.0 kHz) produced consistent data.

References

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

International Atomic Energy Agency, 1991. Airborne Gamma Ray Spectrometric Surveying. Technical Reports Series, No. 323, Vienna.

International Atomic Energy Agency, 2003. Guidelines for Radioelement Mapping Using Gamma Ray Spectrometry Data. Technical Reports Series, No. 1363, Vienna.

Miller, H.G., and Singh, V.J., 1994. Potential Field tilt - A new concept for location of potential field sources. Applied Geophysics, 32, 213-217.

Nelson, J.B., 1994. Leveling total-field aeromagnetic data with measured horizontal gradients. Geophysics, 59, 1166-1170.

Data Accessibility

Data compilation and initial map production were performed by Terraquest Airborne Geophysics Limited, Markham, Ontario. Contract/project management and final map production were provided by the Newfoundland and Labrador Department of Energy and Mines.

Copies of this map may be obtained from the Geological Survey, Department of Energy and Mines, Government of Newfoundland and Labrador, PO Box 8700, St. John's, NL, Canada, A1A 4J6. This map is subject to revision and modification. Comments to the author concerning errors of omissions are invited.

Department website: https://www.gov.nl.ca/em
Geoscience Online website: https://gis.geosurv.gov.nl.ca
Email: pub@gov.nl.ca

11.7
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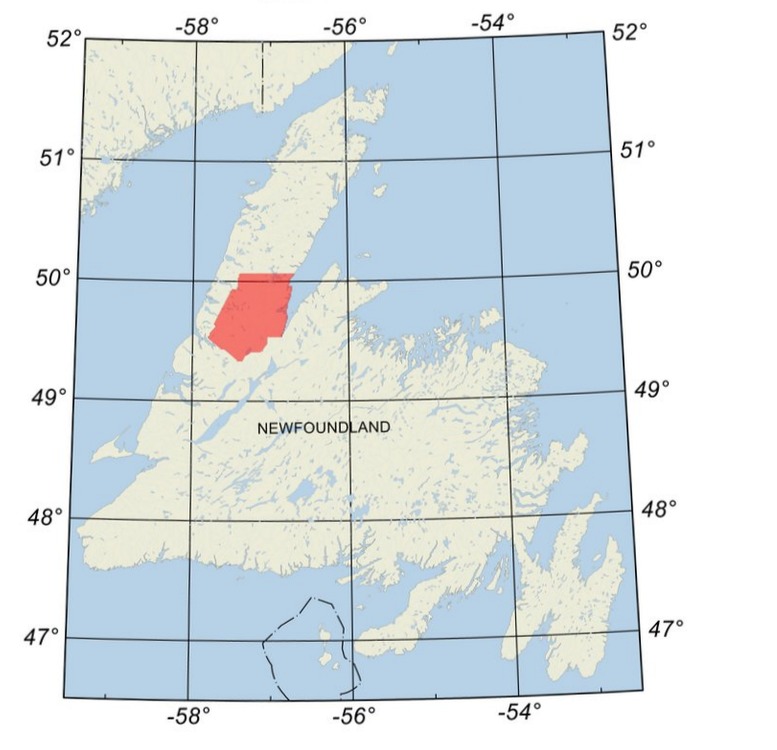
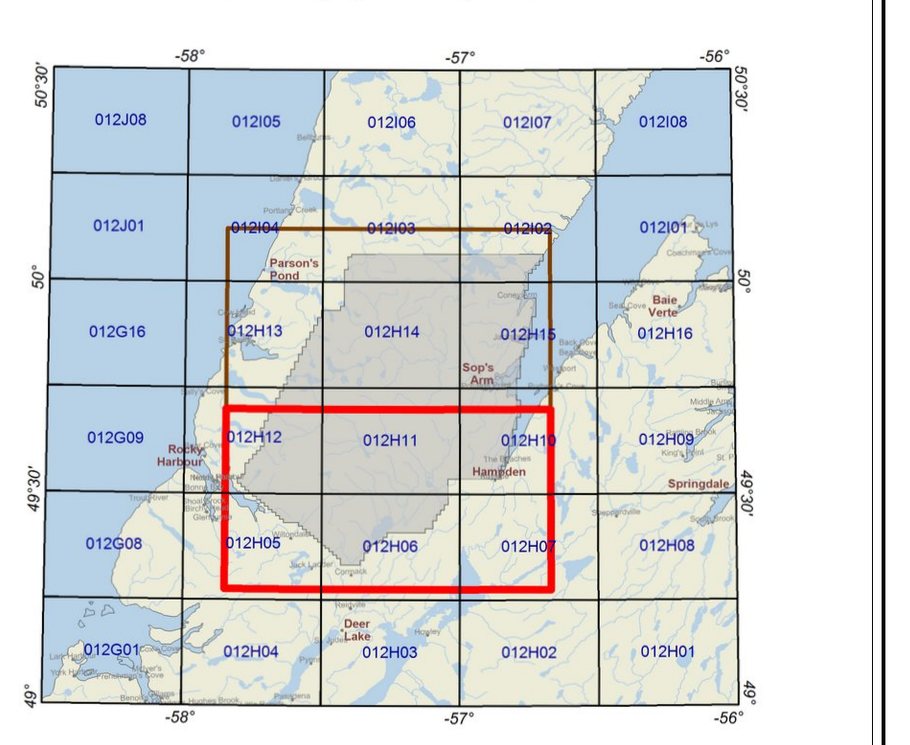
Thorium/Potassium
(eTh/K Ratio)

LOCATION MAP



National Topographic System Reference and Geophysical Map Index



Planimetric Symbols

Topographic Contour
Water Body and Drainage
Road
Building
Powerline
Flightline

Digital topographic data provided by
Geomatics Canada, Natural Resources Canada
Topographic contours at 20 metre interval

MAP 2026-31

RATIO OF EQUIVALENT THORIUM TO POTASSIUM

Airborne Geophysical Survey
White Bay West Area, Western Newfoundland

Map Sheet 2 - Parts of NTS
12H/05,06,10,11,12

Scale 1:100 000
2 0 2 4 6
(kilometres)
NAD83 / UTM zone 21N
Universal Transverse Mercator Projection
North American Datum 1983

Flown and compiled by
TERRAQUEST AIRBORNE GEOPHYSICS

Atlantic Canada Opportunities Agency
Agence de promotion économique du Canada atlantique

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Canada

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