

**AIRBORNE GEOPHYSICAL SURVEY OF THE  
TWILLICK BROOK REGION, NEWFOUNDLAND**

NTS MAP AREA 2D/04 AND  
PARTS OF 1M/13, 1M/14, 2D/03 AND 2D/05,

TERNARY RADIOELENO IMAGE

MAP 2020-10  
OPEN FILE NFLD/3383  
Map 10 of 13

G.J. Kilfoil

**ABOUT THE SURVEY**

**Introduction**  
The ternary gamma-ray spectrometric, aeromagnetic and VLF-EM electromagnetic geophysical survey of Twillick Brook region, Newfoundland, was completed by Sander Geophysics Limited. The survey was flown from October 17th to November 15th, 2019 using a single channel (SC) aircraft. The control points and control line spacings were, respectively, 50 m and 100 m and the aircraft flew at a nominal terrain clearance of 200 and 210 m. Terrain lines were oriented 135° with orthogonal control lines. The flight path was recovered following post-flight Precise Point Positioning (PPP) corrections using precise ephemerides applied to raw data recorded by a Global Positioning System.

**Gamma-ray Spectrometric Data**  
The airborne gamma-ray measurements were made with a Sander Geophysics SGL-200 gamma-ray spectrometer using fourteen 102x102x40 mm NaI(Tl) crystals. The main detector array consisted of twelve crystals (total volume 50.4 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 continuously adjusted the gain of each crystal by monitoring the natural potassium, uranium, and thorium peaks. Ground crystals were provided a small cesium source to supplement the three natural peaks.

Potassium is measured directly from the 1460 keV gamma-ray photons emitted by <sup>40</sup>K, whereas uranium and thorium are measured indirectly from gamma-ray photons emitted by daughter products (<sup>214</sup>Pb for uranium and <sup>214</sup>Pb/<sup>214</sup>Bi for thorium). Although these daughters are far from 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, U<sub>eq</sub> and Th<sub>eq</sub>. The energy windows used to measure potassium, uranium and thorium are respectively 1311-1313 keV, 1960-1965 keV and 2119-2121 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 1960-1965 keV window and radon at energies greater than 3000 keV were recorded in the cosmic window. The window counts were corrected for background activity from cosmic radiation, radioactivity of the aircraft and atmospheric radon decay products. The window data were then corrected for spectral spreading in the ground, all 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 Brocktonage, Quebec, calibration range.

Corrected data were interpolated to a 30 m grid interval. The results of an airborne gamma-ray spectrometric survey represent the average surface concentrations that are influenced by varying amounts of outcrop, overburden, vegetation cover, soil moisture and surface water. As a result the measured concentrations are usually lower than the actual bedrock concentrations. The soil an absorption 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 three split-beam cesium vacuum magnetometers (sensitivity = 0.005 nT) mounted inside the tail boom and two wingspans of the aircraft. The array of sensors from a horizontal gradiometer with a largest dimension of 19.02 m and a longitudinal dimension of 10.04 m. Differences in magnetic values at the intersections of control and traverse lines were computed and used to produce a regular grid of magnetic data. The International Geomagnetic Reference Field (IGRF) defined at the average GPS altitude of 313 m for the date November 1st was then removed. Removal of the IGRF, representing the magnetic field of the Earth's core, provides a residual component related essentially to magnetizations within the Earth's crust. An enhanced version of the levelled magnetic data is calculated by leveraging horizontal and longitudinal gradients to better define short wavelength signals which is then interpolated to a 30 m grid interval.

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 steeply sloped anomalies. A product 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).

**VLF-EM**  
Very low frequency (VLF) electromagnetic data was measured using a Hertz Teton 2A VLF-EM receiver mounted in a 2.5 m frequency stringer installed on the tail of the aircraft. For this survey, the VLF stations in Labrador, North Dakota (22.1 kHz) provided Line data and Rheinlander, Germany (22.4 kHz), and Shelton, UK (22.1 kHz) provided Ortho data. Due to intermittent signal transmission from the VLF stations, 100% VLF coverage of the survey area was not achieved. Variation in signal quality is also apparent in the data as bands of less coherent data.

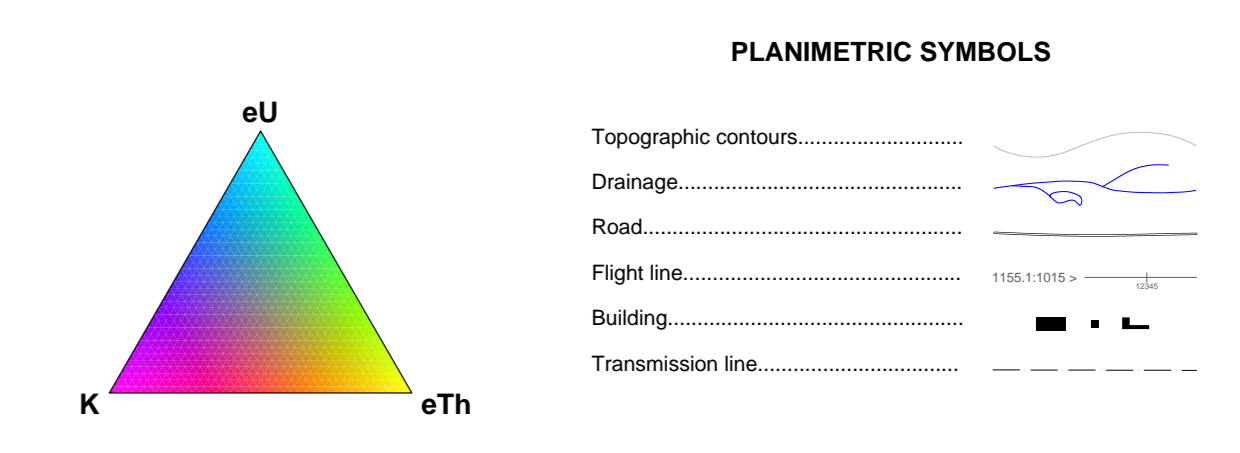
**Additional Information**  
Data compilation and map production were performed by Sander Geophysics Limited, Ottawa, Ontario. Contract and project management was provided by the Newfoundland and Labrador Department of Natural Resources. Copies of this map may be obtained from the Geological Survey, Department of Natural Resources, Government of Newfoundland and Labrador, PO Box 8700, St. John's, NL, Canada, A1B 4X6.

The map is subject to revision and modification. Comments to the author concerning errors or omissions are invited.  
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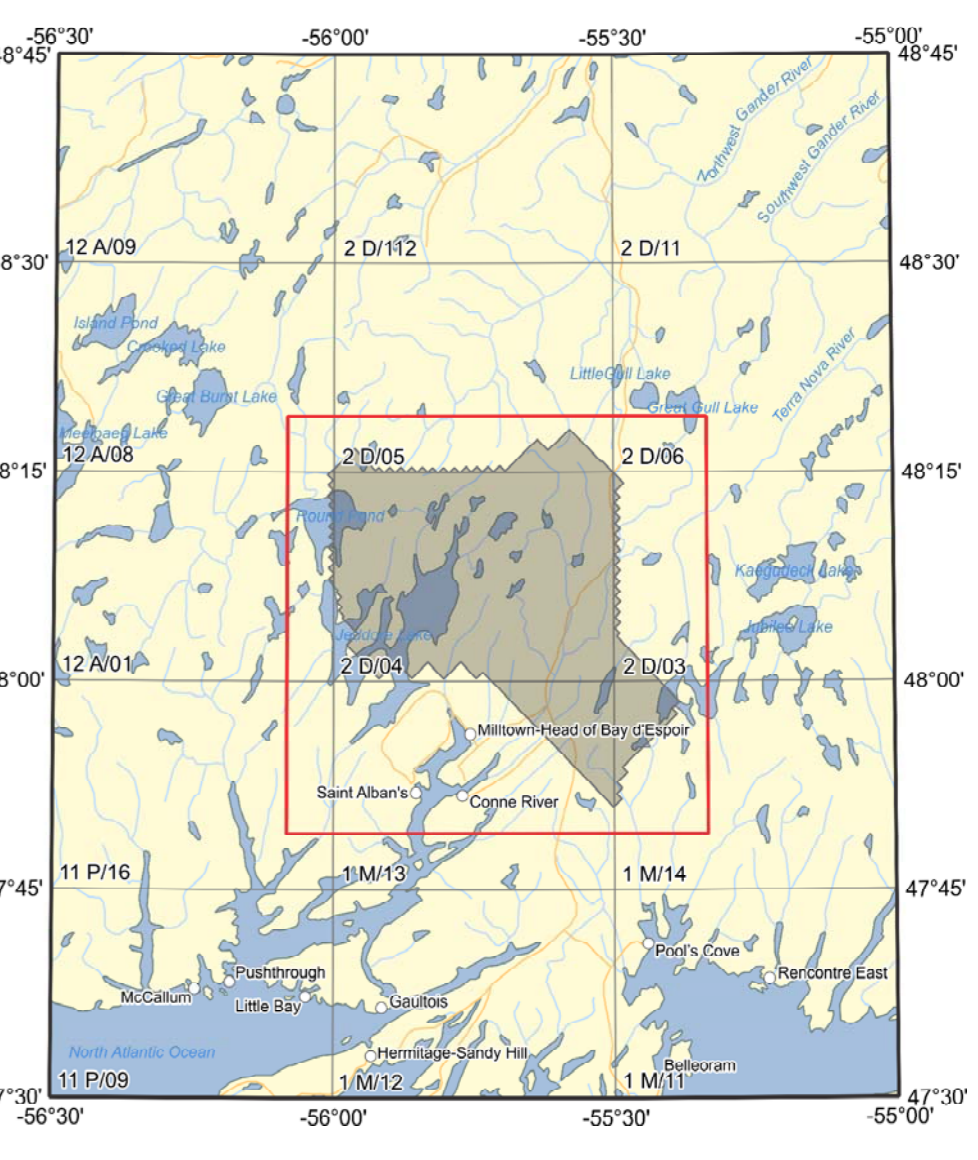
**References**  
Hood, P.J., 1965. Gradient measurements in aeromagnetic surveying. *Geophysics*, vol. 30, p. 891-902.

**PLANIMETRIC SYMBOLS**

Topographic contours	
Drainage	
Road	
Flight line	
Building	
Transmission line	



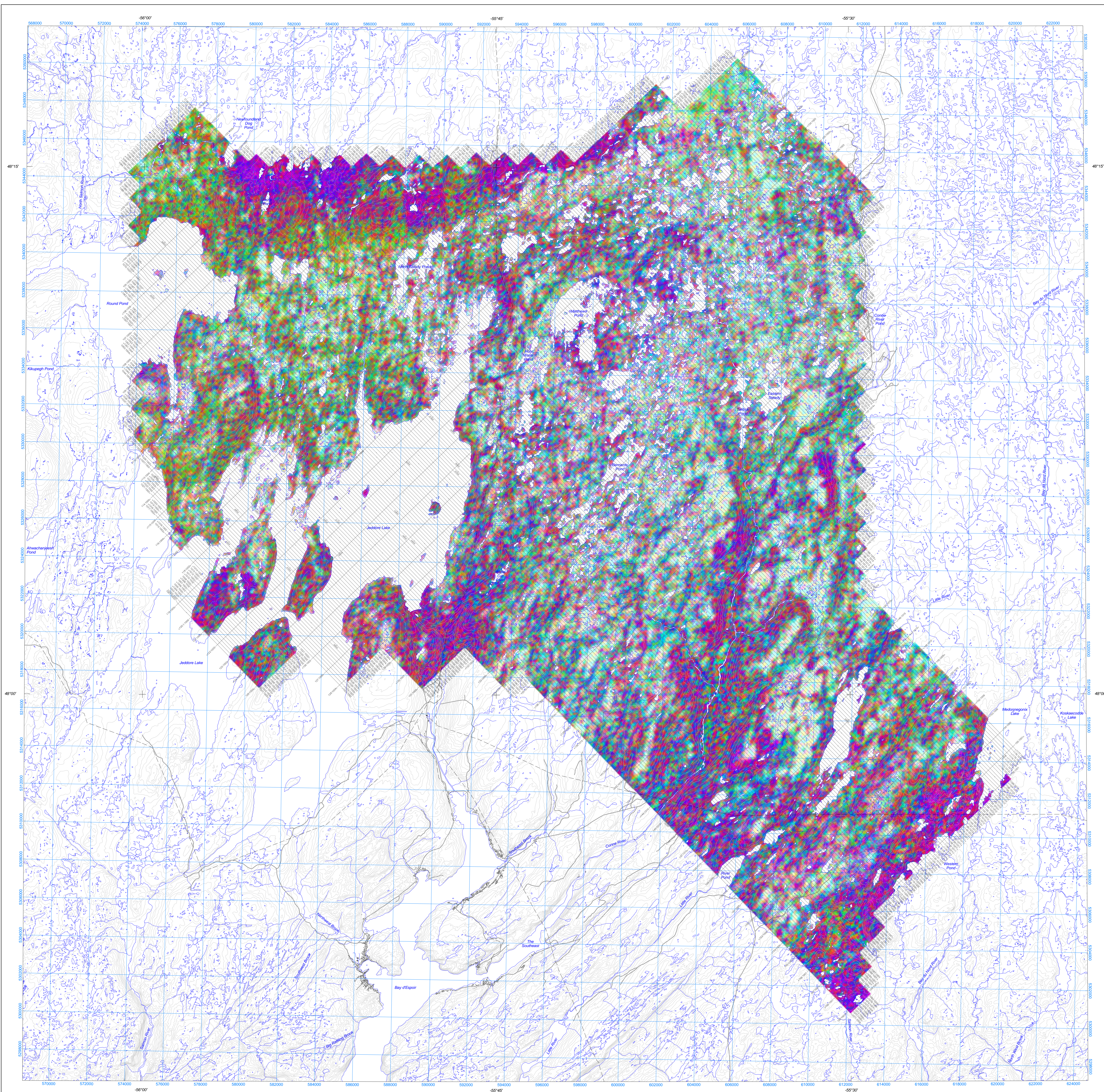
**NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND GEOPHYSICAL MAP INDEX**



**Recommended Citation**  
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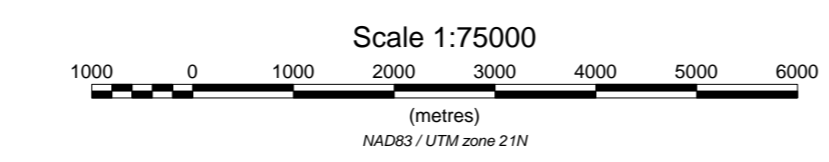
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Topographic contour interval: 30 metres

**MAP 2020-10  
TWILLICK BROOK  
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Digital topographic data provided by Geomatics Canada, Natural Resources Canada