

**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,

(VLF-EM TOTAL FIELD - 23.4 & 22.1, KH)
(Rhauderföhn, Germany & Skelton, UK)

MAP 2020-12
OPEN FILE NFLD/3383
Map 12 of 13

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ABOUT THE SURVEY

Introduction
The aeromagnetic, aerogeophysical and VLF-EM 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 VLF-EM system (VLF-EM). The control traverse 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-500 gamma-ray spectrometer using fourteen 100x100x40 mm NaI(Tl) crystals. The main detector array consisted of twelve crystals (total volume 0.4 m³) in two columns (total volume 0.4 m³) stacked 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 ⁴⁰K, whereas uranium and thorium are measured indirectly from gamma-ray photons emitted by daughter products (²¹⁴Pb for uranium and ²¹⁴Pb 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, U_{eq} and Th_{eq}. The energy windows used to measure potassium, uranium and thorium are respectively 1317-1319 keV, 1560-1600 keV and 2112-2113 keV.

Gamma-ray spectra were recorded at one-second intervals. Data processing followed standard procedures as described in IAEA, 1981 and IAEA, 2003. During processing, the spectra were energy calibrated, and counts were accumulated into the windows described above. Counts from the radon detector were recorded in a 1600-1800 keV window and radon at energies greater than 2000 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 scattering in the ground. 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, Quebec, calibration range.

Corrected data were interpolated to a 30 m grid interval. The results of an airborne gamma-ray spectrometer 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 nanograms 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 vapour magnetometers (sensitivity = 0.005 nT) mounted inside the tail boom and two wing pods of the aircraft. The area of interest from a horizontal grid square 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 normally analysed to create a quality level set of high-quality 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, produces a residual contour 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.

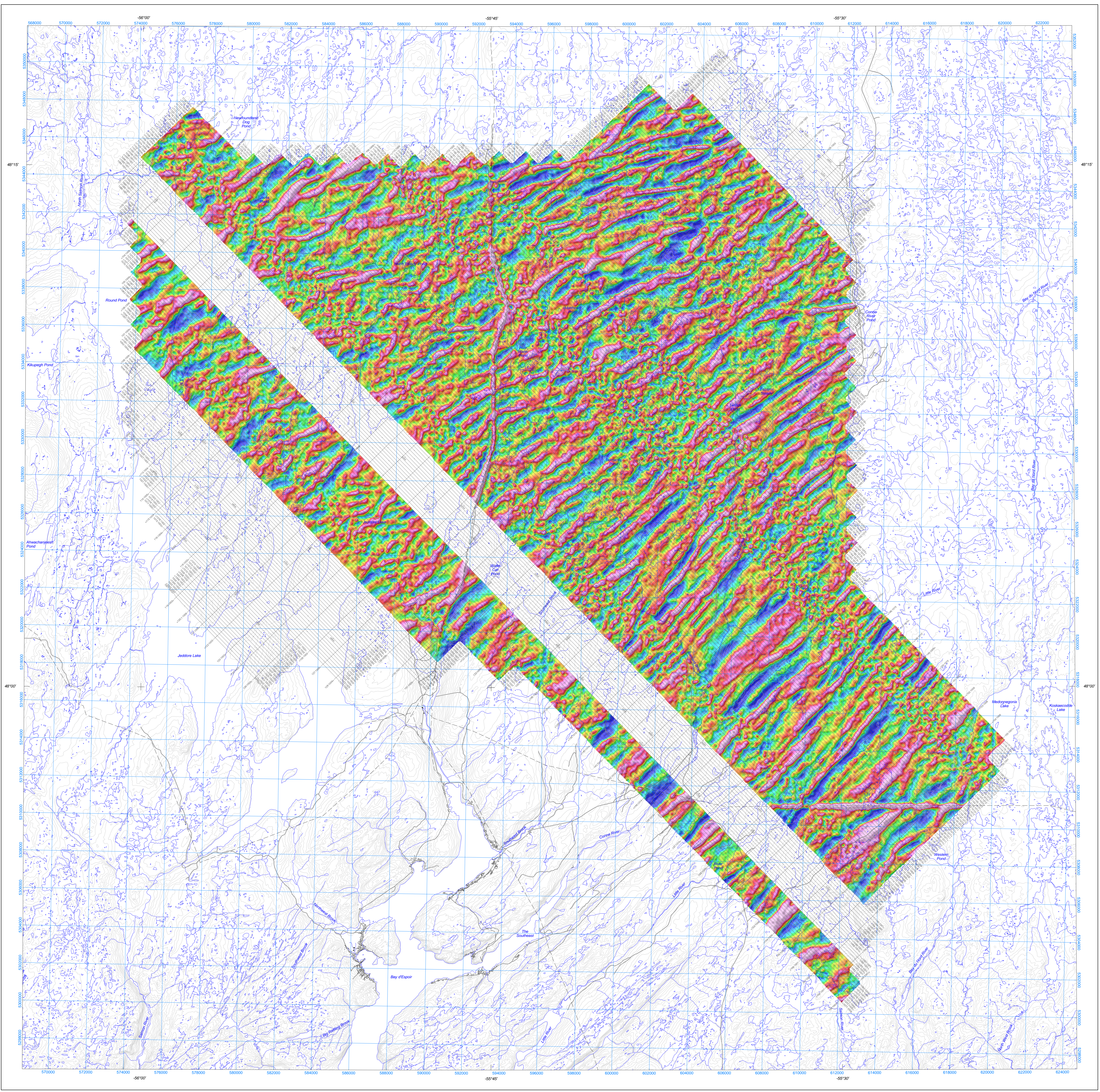
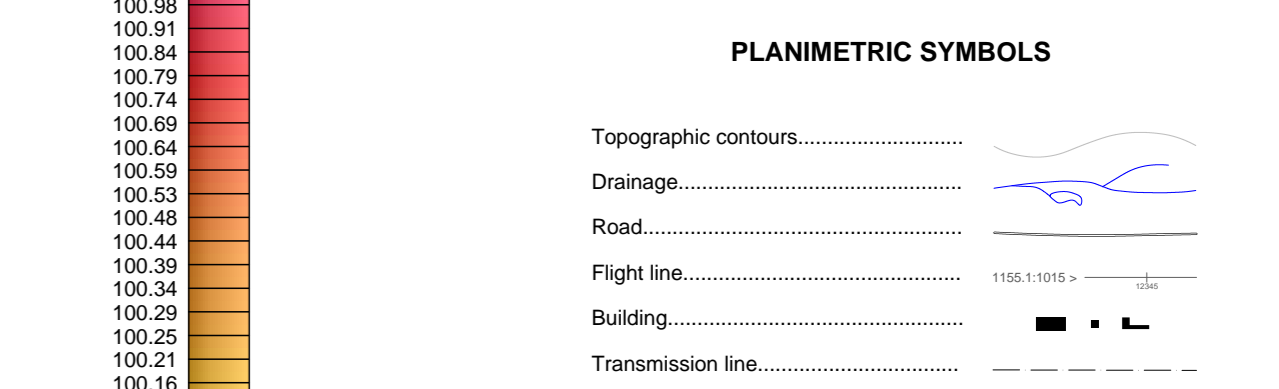
The first vertical derivative of the magnetic field is the rate of change of the magnetic field in the vertical direction. Computation of the first vertical derivative removes long wavelength features of the magnetic field and significantly improves the resolution of closely spaced and steep-sided anomalies. 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 Telen 2A VLF-EM receiver mounted in a 2.5 m fibre-glass stringer attached to the tail of the survey plane. For this survey, the VLF stations in Labrador, North Dakota (22.1 kHz) provided raw data and Rhauderföhn, Germany (23.4 kHz), and Skelton, UK (22.1 kHz) provided control 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 4J6.

The map is subject to revision and modification. Comments to the author concerning errors or omissions are invited. Department Website: <http://www.gov.nl.ca/nr> Geological Survey Website: <http://www.nr.gov.nl.ca/nr> E-mail: sge@gov.nl.ca

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



Topographic contour interval: 30 metres
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