Natural Resources Canada / Ressources naturelles Canada

CANADIAN GEOSCIENCE MAP 291

SEASONAL SURFACE DISPLACEMENT DERIVED FROM DINSAR

RANKIN INLET

Nunavut

Map Information Document

Preliminary

Geological Survey of Canada
Canadian Geoscience Maps

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ABSTRACT

This map shows the relative ground surface displacement between the major terrain units during one summer in the area of Rankin Inlet. The ground displacement was derived using differential interferometric synthetic aperture radar (DInSAR) data for the summer of 2015. DInSAR data came from the Canadian RADARSAT-2 satellite which operates with a C-band SAR. Stable ground represents locations where either no vertical change was calculated or where displacement was within the expected range of error (± 1.0 cm). Downward displacement represents, in general, ground surface lowering (subsidence) on the order of 1.0 to 2.5, 2.5 to 4.0, 4.0 to 6.0, 6.0 to 8.5, and 8.5 to 14.0 cm. Other possible causes of apparent downward displacement could be associated with downward surface water table movement throughout the summer and sediment erosion. Upward displacement represents a surface rise of 1.0 to 5 cm, which is only 0.3% of the total coverage of the DInSAR map. Areas of no data result from a loss of interferometric coherence. These are typically water and other relatively smooth surfaces from which there is no radar return, or where there has been significant ground surface disturbance and the radar returns cannot be correlated.

RÉSUMÉ

Cette carte montre les mouvements relatifs du sol entre les principales unités de terrain de la région de Rankin Inlet au cours d'un été. Les mouvements du sol calculés découlent de données d'interférométrie différentielle par radar à synthèse d'ouverture (DInSAR) pour l'été 2015. Les données DInSAR ont été acquises par le satellite canadien RADARSAT-2, qui exploite un radar à synthèse d'ouverture (RSO) dans la bande C. Un sol stable représente une zone où, selon les calculs, il n'y a pas de changement vertical de la surface du sol ou que celui-ci se situe à l'intérieur de la marge d'erreur (± 1,0 cm) attendue. En général, les déplacements vers le bas représentent un abaissement de la surface du sol (subsidence) de l'ordre de 1,0 à 2,5 cm, 2,5 à 4,0 cm, 4,0 à 6,0 cm, 6,0 à 8,0 cm et 8,0 à 14,0 cm. D'autres causes d'un déplacement apparent vers le bas de la surface du sol pourraient être associées à un abaissement du niveau de la nappe d'eau de surface au cours de l'été ou à l'érosion de sédiments. Un déplacement vers le haut correspond à une hausse de la surface du sol de 1,0 à 5 cm. Ces zones ne représentent que 0,3% de la couverture totale de la carte DInSAR. Les zones sans données sont le résultat d'une perte de cohérence interférométrique. Ces zones correspondent typiquement aux étendues d'eau et aux surfaces relativement lisses qui ne produisent pas de signal radar de retour ou à des zones où une perturbation importante de la surface du sol produit des signaux radar de retour qui ne peuvent être corrélés.

Sheet 1 of 1, Seasonal surface displacement derived from DInSAR

General Information

Authors: N. Short, A.-M., LeBlanc, and O. Bellehumeur-Génier

Geology by I. McMartin, 1997–1999

Surficial geology data conversion by D.E. Kerr, 2016

Geology has been spatially adjusted to fit the updated base.

Geomatics by O. Bellehumeur-Génier

Cartography by O. Bellehumeur-Génier and E. Everett

Map projection Universal Transverse Mercator, zone 15.
North American Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications.

Shaded relief image prepared by O. Bellehumeur-Génier and derived from the digital elevation model created from 50 cm stereo-optical satellite images acquired August, 2012 (Worldview-1) and June, 2014 (Worldview-2). Worldview: ©DigitalGlobe, all Rights Reserved. 1 m DEM created using a proprietary stereo image matching process by PhotoSat Information Ltd. Illumination: azimuth 315°, altitude 45°, vertical factor 1x

Magnetic declination 2016, 6°58'E, decreasing 4.2' annually.

This map is not to be used for navigational purposes.

Title photograph: Rankin Inlet inuksuk, Rankin Inlet, Nunavut. Photograph by A.-M. LeBlanc. 2016-055

The Geological Survey of Canada welcomes corrections or additional information from users.

Data may include additional observations not portrayed on this map. See documentation accompanying the data.

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Preliminary publications in this series have not been scientifically edited.

Map Viewing Files

The published map is distributed as a Portable Document File (PDF), and may contain a subset of the overall geological data for legibility reasons at the publication scale.

Descriptive Notes

Correlation with surficial geology

Surficial geology was mapped by McMartin (2002) at a scale of 1:50 000 for the Rankin Inlet area and updated recently to conform to the Surficial Data Model v. 2.1. The DInSAR results correspond well with the expected displacement associated with the characteristics of the surficial geology units. The most common surficial units classified as stable are bedrock (50% of unit R), glaciofluvial sediments (sands and bouldery gravel; including eskers, 43% of unit GF), and beach sediments (sand and gravel; generally well sorted material, 38% of unit Mr). These units generally have low pore ice content, and will not subside upon thawing. The road network, including the Iqalugaarjuup Nunanga Territorial Park access road, often intersects one of these units. Bedrock, esker and beach sediments commonly occur on topographic highs, thus ideal for road paths. The highest values of downward displacement (> -6 cm), for summer 2015, are mostly associated with intertidal sediments (17% of unit Mi), deltaic sediments (14% of unit Md), alluvial and marine undifferentiated sediments (13% of unit A.M), and nearshore sediments (8% of unit Mn). With the exception of deltaic sediments (coarse sand, gravel, and boulders), these units are characterized by a significant amount of fine-grained sediments (silts and/or clays) which are often associated with thaw-sensitive terrain (ice-rich). In addition, the alluvial-marine undifferentiated sediments are characterized by surface water runoff features and high water table (McMartin, 2002). Therefore, the downward displacement calculated by DInSAR for this particular unit, may have resulted from a complex interaction between ground surface subsidence and surface water movement. The relatively high DInSAR downward displacement observed for the deltaic sediments (at the Meliadine River mouth), is likely related to surface water movement and erosion.

Rankin Inlet area

In town, the modification of surface conditions by adding fill material (roads, airport infrastructure, gravel pads below buildings, etc.) reduced the amount of seasonal downward displacement; these areas are usually more stable than their natural surficial foundation. The commercial areas, also located on past mining facilities, appeared slightly more stable than the residential areas. This is especially apparent in the old part of town (residential), although both areas are located on till and marine undifferentiated sediments (unit T.M). This phenomenon was also observed at the airport where the runway, the runway shoulders, aprons, taxiways, and the military facility appeared mostly stable.

The natural terrain northwest of the current runway was altered several times during construction and upgrading of the airport facilities (Fig. 1; polygons 1 and 3). A well-developed network of ice-wedge polygons, located in a topographic high made of marine beaches (unit Mr), was clearly visible at the north end of the runway in 1961, before the runway extension (Fig. 2). Despite the numerous ice-wedges, the sand and gravel of the Mr unit was probably used as a source of fill material for runway extension. A subset of this reworked sector (mostly on unit T.M), appeared drier (more recent) on the 1992 air photo, which perfectly matches the area of stable DInSAR values (Fig. 1 and 3; polygon 3).

Another subset of the Mr unit, on the northeast of the runway, remained more or less untouched through time. This area includes a past beach spit (McMartin, pers. comm., 2016) and is more stable than the surrounding terrain (Fig. 1 to 3; polygon 2). Polygon 2 is more stable than the reworked Mr and T.M unit areas (polygon 1) on the northwest of the runway (Fig. 1). Fill material was also used on the northeast side of the runway where the DInSAR shows stable ground (Fig. 1 and 3; polygon 4).

In addition, in 1993, a layer of rigid styrofoam insulation was incorporated in the base structure of the runway to limit degradation of the underlying permafrost and pavement resurfacing was also done in 2008 (LPS Aviation Inc., 2010). According to the DInSAR results, the natural foundation of the runway (mostly on unit Mr), the use of fill material for embankment, mitigation method (insulation) and maintenance seemed to have played a role in maintaining the runway in operational condition. Taxiway C is the only section of the airport showing significant displacement. Further investigation in this area would be needed to identify the cause.

Some buildings and roads, including portions of the airport area were built on small lakes drained prior to construction. These are shown as historical lakes in the inset above (from 1965 air photo (A18916-104)). There is no obvious relationship between the presence of past lakes and relatively high downward displacement values. Most of the historical lakes were located in beach, nearshore, and till and marine undifferentiated sediments and the displacements within these past lakes are most likely related to the surficial units and/or the addition of fill material.

ACKNOWLEDGMENTS

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DISCLAIMER

REFERENCES

LPS Aviation Inc., 2010. Rankin Inlet Airport Master Plan; Report prepared for Nunavut Airports, Department of Economic Development and Transportation, Government of Nunavut, 107 pp.

McMartin, I., 2002. Surficial geology, Rankin Inlet, Nunavut; Geological Survey of Canada, Open File 4116, scale 1:50 000. doi:10.4095/213219

AUTHOR CONTACT

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COORDINATE SYSTEM

Projection: Universal Transverse Mercator
Units: metres
Zone: 15
Horizontal Datum: NAD83
Vertical Datum: mean sea level

BOUNDING COORDINATES

Western longitude: 92°28’00”W
Eastern longitude: 92°03’00”W
Northern latitude: 62°54’15”N
Southern latitude: 62°47’30”N

DATA MODEL INFORMATION

No Model

This Canadian Geoscience Map does not conform to either the Bedrock or Surficial Mapping Geodatabase Data Models. The author may have included a complete description of the feature classes and attributes in the Data\Data Model Info folder.