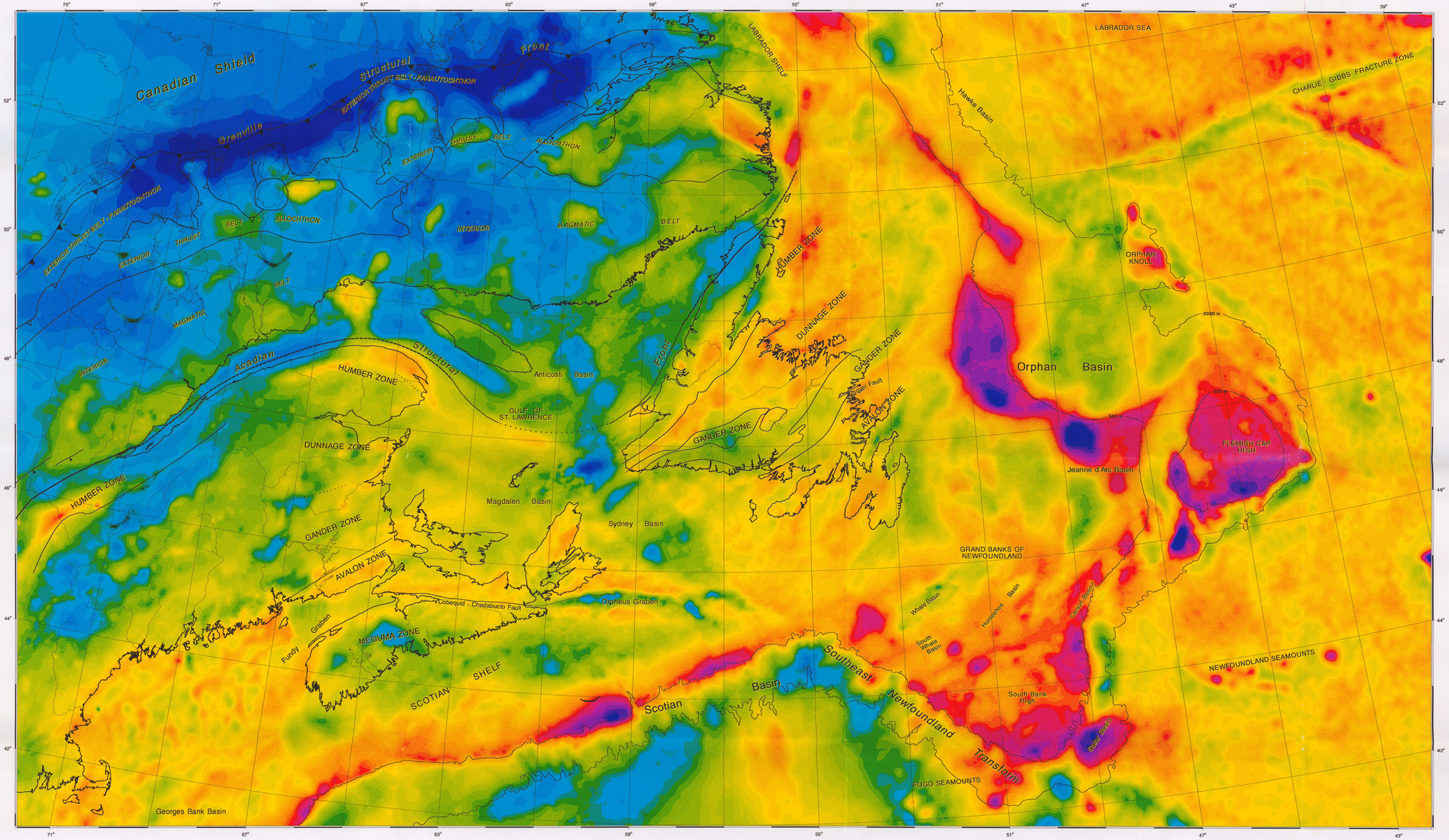
Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA | COMMISSION GÉOLOGIQUE DU CANADA

Memorial University of Newfoundland



GRAVITY ANOMALY

The Atlantic region of Canada includes three major tectonic assemblages: the Proterozoic Grenville Orogen, the Paleozoic Appalachian Orogen, and the Mesozoic/Cenozoic Atlantic continental margin. The map overlay shows the division of the orogens and related components into zones based on composition, age and ancestry (after Williams and Grant, 1998). Each of these entities has a distinct gravity signature, indicating significant variation in near-surface and deeper crustal structure between the major assemblages, and the general trend is of increasing values from the Grenville Structural Front to the edge of the continent. Detailed studies and interpretations of the gravity anomalies were reviewed by Woodside and Verhoef (1989). Miller (1995), Keen et al. (1990), and Williams et al. (1994). A brief summary is presented here.

Gravity anomalies over the Grenville Orogen are considerably more negative than elsewhere in the region, with values typically less than -50 mGal. The greater crustal thickness and higher elevations of the orogen account for much of the regional low, especially over the Exterior Thrust Belts. The boundary between the orogen and the older provinces of the Canadian Shield is marked by a pronounced band of negative anomalies. Anomaly values are slightly higher over the Interior Magmatic Belt, where broad negatives generally coincide with large anorthosite massifs and local positives are associated with metagabbroic rocks. Grenville rocks underlie the Humber Zone of the Appalachian Orogen and the thick sequences of early Paleozoic rocks that were deposited in flexural basins formed in advance of the overriding Appalachian material (e.g. Anticosti Basin). Negative gravity anomalies tend to be associated with the sedimentary basins, and a gravity gradient in the Gulf of St. Lawrence delineates the Acadian Structural Front that separates the Appalachian Orogen from the Paleozoic St. Lawrence Platform.

Gravity anomalies associated with the Appalachian allochthons are generally in the -40 to +40 mGal range. The highest values correlate with the dominantly mafic volcanic and plutonic rocks of the Dunnage Zone which crosses Newfoundland and extends offshore to the northeast. Some of the lowest values are associated with metasedimentary rocks of the adjacent Gander Zone, which also has inliers within the Dunnage Zone. Positive gravity anomalies are associated with the volcanic, intrusive, and metamorphic rocks of the Avalon Zone in southeast Newfoundland and northern Nova Scotia. The contact between the Avalon and the Meguma Zone to the south is marked in Nova Scotia by the Cobequid-Chedabucto shear zone. Gravity values decrease sharply across this boundary, and the feature can be followed offshore for several hundred kilometres to the east over the Orpheus Graben. The layered sedimentary rocks of the Meguma Zone in Nova Scotia produce slightly negative gravity anomalies, and large granitic intrusions locally produce stronger negatives.

The Atlantic continental margin preserves in numerous Mesozoic basins the record of lithospheric stretching and subsidence. Rift basins that formed as grabens or half-grabens during the opening of the North Atlantic, such as the Whale and Jeanne d'Arc basins, generally have negative gravity anomalies associated with them. Broad positive anomalies are associated with the relatively thick crust, and shallow basement, of the Flemish Cap and South Bank highs. The most notable feature in the offshore, however, is the large positive free-air anomaly that follows the 500 m bathymetric contour at the edge of the continental shelf and around the edge of Flemish Cap. Seaward of this feature the continental crust has been thinned in response to rifting, and the shape of the anomaly appears to be related to the style and intensity of crustal thinning. Basins that developed over broad zones of thinned crust, such as the Scotian and Orphan basins, have both positive and negative anomalies associated with them, indicative of regional isostatic compensation. The boundary between continental and oceanic crust lies close to the 3000 m bathymetric contour, and gravity anomalies assume a more uniform character over the oceanic crust. The Newfoundland and Fogo seamount chains are marked by strings of small positive anomalies. A prominent oceanic feature, the Charlie-Gibbs Fracture Zone, is marked by a linear negative anomaly.

Keen, C.E., Loncarevic, B.D., Reid, I., Woodside, J., Haworth, R.T. and Williams, H. Tectonic and geophysical overview; Chapter 2 in Geology of the Continental Margin of Eastern Canada, M.J. Keen and G.L. Williams (ed.); Geological Survey of Canada, Geology of Canada, no. 2, p. 31-85. (also Geological Society of America, The Geology of North America, v. I-1), 1990.

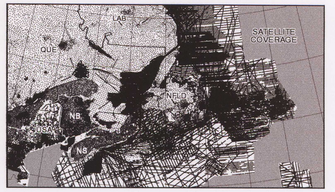
Miller, H.G. Geophysical characteristics; Chapter 7 in Geology of the Appalachian-Caledonian Orogen in Canada and Greenland, H. Williams (ed.); Geological Survey of Canada, Geology of Canada, no. 6, p. 603-627. (also Geological Society of America, The Geology of North America, v. F-1), 1995.

Williams, H. and Grant, A.C. Tectonic assemblages map, Atlantic Region, Canada. Geological Survey of Canada, Open File 3657, scale 1:3000000, 1998.

Williams, H., MacNab, R. and Shih, K.G. Major structural features of southeastern Canada and the Atlantic continental margin portrayed in regional gravity and magnetic maps. Geological Survey of Canada, Paper 90-16, 1994.

Woodside, J.M. and Verhoef, J. Geological and tectonic framework of eastern Canada as interpreted from potential field imagery. Geological Survey of Canada, Paper 88-26. 1989.

GRAVITY DATA DISTRIBUTION



The data sets used to produce this map include land station measurements, marine surface and seafloor measurements, and values derived from satellite altimetry. Data distribution and coverage are shown on the map above. The average spacing of regional observations is 5-10 km for land measurements and between 2-5 km for shipsracks, with considerably more detailed surveying in targeted areas. Marine survey data were filtered to remove trackline problems prior to final gridding at 2 km intervals. Free-air anomalies over the deeper water of the slope and ocean basin were filled in using the 2-minute global gravity grid derived by Sandwell and Smith (1997) from ERS-1 and GEOSAT satellite altimetry. The satellite gravity values were base-level adjusted and merged over a 30 km wide zone with the marine survey data. Bouguer anomaly data for the landmasses, corrected for elevation effects with a reducing density of 2.67 gcm^{-3}, were gridded and merged with the marine free-air anomaly grids. Station and survey data were provided by the Geophysical Data Centre, Continental Geoscience Division, GSC Ottawa.

Earth Physics Branch. Integration of Atlantic Geoscience Centre marine gravity data into the National Gravity Database. Earth Physics Branch, Open File 85-32, Ottawa, 1985.

Sandwell, D.T. and Smith, W.H.F. Marine gravity anomalies from Geosat and ERS-1 satellite altimetry. Journal of Geophysical Research, 102, 10039-10054, 1997.

ATLANTIC CANADA MAP SERIES
GEOPHYSICS, GEOLOGY AND PHYSIOGRAPHY

PROJECT TEAM:
S.A. DEHLER (GSC Atlantic, Coordinator)
A.C. GRANT, R. MACNAB, G.N. OAKEY (GSC Atlantic)
H. WILLIAMS (Memorial University of Newfoundland)

THE EFFORTS OF MANY OTHERS WHO PARTICIPATED IN THIS PROJECT ARE GRATEFULLY ACKNOWLEDGED
DEDICATED TO OUR LATE COLLEAGUE AND FRIEND, ALLEN STARK

KEY TO STRUCTURAL LINES

- Grenville Structural Front
- Front of Labradorian allochthons
- Tectonic Zone Boundaries (assumed, speculative)
- Acadian Structural Front : onland, marine, sub-Carboniferous, presumed
- Normal Faults
- 500m, 3000m bathymetric contours

LOCATION MAP - LOCALISATION DE LA CARTE

GRAVITY ANOMALY MAP
BOUGUER ON LAND, FREE-AIR AT SEA
ATLANTIC REGION
CANADA

Scale 1:3 000 000 - Échelle 1:3 000 000

Kilometres 50 0 50 100 150 200 250 Kilometres

Lambert Conformal Projection
Standard Parallels 49°N and 69°N CM=57°W

-100 -80 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 80 100 mGal

Special thanks to J. Tod and W. Miles of the Geophysical Data Centre (GSC, Ottawa) for providing gravity point data for the Canadian land mass. G. N. Oakey is thanked for helpful discussions concerning the data compilation. Digital cartography was provided by David Vardy. The basemap was created using the World Vector Coastline high resolution data.

Copies of this map can be obtained from the Geological Survey of Canada (Atlantic) PO Box 1006, Dartmouth, Nova Scotia, Canada, B2Y 4A2
email: agc@agc.bio.ns.ca
web: http://agcwww.bio.ns.ca

Specific inquiries can be sent to Dr. S.A. Dehler, GSC (Atlantic).
tel: 1-(902)-426-4289
email: dehler@agc.bio.ns.ca

OPEN FILE
DOSSIER PUBLIC
3658
GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
OTTAWA
1998

Canada

Recommended Citation:

Dehler, S.A. and Roest, W.R., 1998
Gravity Anomaly Map, Atlantic Region, Canada.
Geological Survey of Canada Open File 3658,
scale 1:3000000.