Newfoundland Labrador

Industry, Energy and Technology

Mines

RECONNAISSANCE-LEVEL LITHOGEOCHEMICAL SAMPLING OF IGNEOUS ROCKS FROM THE AVALON TERRANE, EASTERN NEWFOUNDLAND (NTS MAP AREAS 1M/3, 10, 1N/5, 6, 10, 11 AND 12)

A.J. Mills

Open File NFLD/3414

St. John's, Newfoundland
November, 2022

NOTE

Open File reports and maps issued by the Geological Survey Division of the Newfoundland and Labrador Department of Industry, Energy and Technology are made available for public use. They have not been formally edited or peer reviewed, and are based upon preliminary data and evaluation.

The purchaser agrees not to provide a digital reproduction or copy of this product to a third party. Derivative products should acknowledge the source of the data.

DISCLAIMER

The Geological Survey, a division of the Department of Industry, Energy and Technology (the "authors and publishers"), retains the sole right to the original data and information found in any product produced. The authors and publishers assume no legal liability or responsibility for any alterations, changes or misrepresentations made by third parties with respect to these products or the original data. Furthermore, the Geological Survey assumes no liability with respect to digital reproductions or copies of original products or for derivative products made by third parties. Please consult with the Geological Survey in order to ensure originality and correctness of data and/or products.

Departmental website: https://www.gov.nl.ca/iet
Geological Survey website: https://www.gov.nl.ca/iet/mines/geoscience
Email: pub@gov.nl.ca

Recommended citation:
Mills, A.J.

2022: Reconnaissance-level lithogeochemical sampling of igneous rocks from the Avalon Terrane, eastern Newfoundland (NTS map areas 1M/3, 10, 1N/5, 6, 10, 11 and 12). Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Open File NFLD/3414, 8 pages.

CONTENTS

FIGURE

TABLES

SUMMARY

This open file data release consists of whole-rock geochemical data from 35 rock samples collected from various parts of the Avalon Terrane, eastern Newfoundland (Figure 1, NTS map areas 1M/3, 10, 1N/5, 6, 10, 11 and 12). The bedrock geology of the core of the Avalon Peninsula was compiled by McCartney (1967) and the entire Avalon Peninsula (and northwest to include Random Island) was compiled by King (1988). The bedrock geology of the Terrenceville map (1M/10) was completed by O'Brien *et al.* (1984), and the Marystown map was completed by Strong *et al.* (1977). All samples included in this report were collected by A.J. Mills (2022; four samples in 2021). This open file data release provides no interpretation.

NOTES ON THE DATABASE

All data are reported in Zone 22 UTM coordinates. Samples are prefixed by the year and initials of the geologist who collected them. Appendix A contains brief sample descriptions, location data, as well as major- and trace-element whole-rock geochemical analytical data for the samples collected. Analytical duplicates were selected at random and inserted at a frequency of one in 20 (Appendix B). In addition, a number of reference materials (Standards) were analyzed for quality assurance (Appendix C). Details of the analytical methods used are provided by Finch *et al.* (2018) and summarized in Table 1. The data are available in digital format (*i.e.*, comma separated value files; *.csv) through the links provided in the Appendices section.

Major-element compositions (plus Ba, Be, Cr, Sc and Zr) were analyzed using ICP-OES methods, following lithium tetraborate and metaborate fusion. REE and selected trace elements were determined by ICP-MS analysis after lithium tetraborate and metaborate fusion. Other trace elements (As, Cd, Co, Cu, Li, Mo, Ni, Pb, Rb, S, V and Zn) were analyzed by ICP-OES after total 4-acid digestion (note that Rb in the Burin Peninsula samples was analyzed by ICP-MS only). Volatiles are represented as loss-on-ignition (LOI) at 1000°C, which represents the breakdown of all minerals and release of all volatiles. The ferrous-iron content (FeO) of silicate rocks is determined by the Wilson Method (Wilson, 1960), as outlined by Finch *et al.* (2018). For silver analysis, 0.5 g of sample powder was weighed into a 15 ml digestion tube with 2 ml of concentrated nitric acid, and digested for two hours and then analyzed by ICP-OES (Finch *et al.*, 2018). Flouride content is determined as described by Ficklin (1970) and Finch *et al.* (2018).

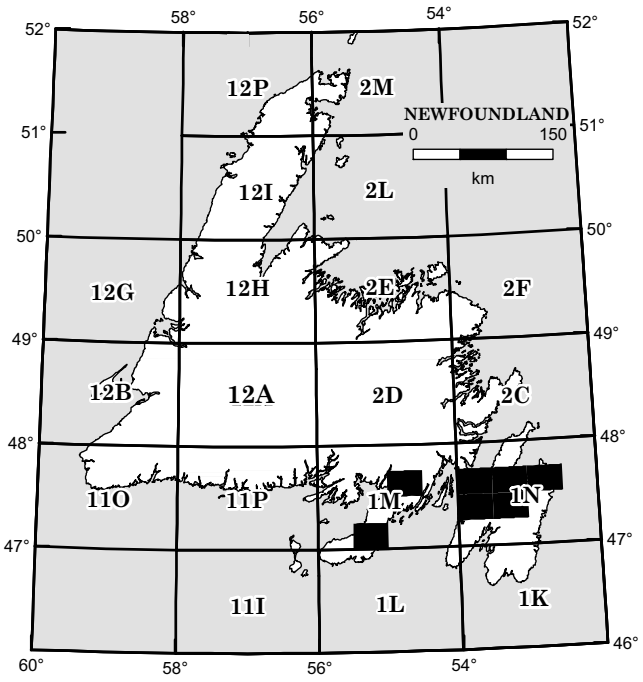

Figure 1. *Location of study area.*

Major elements are reported in weight percent (wt. %), and minor and trace elements are reported in parts per million

Table 1. List of abbreviations

Abbreviation	Explanation
-99	Sample was not analyzed for that element
Avg	Average value
Dup	Duplicate analysis
Fe_2O_3T	Total measured iron
ICP-OES-4-ACID	Inductively Coupled Plasma Optical Emission Spectrometry following HF-HCl-HNO_3-$HClO_4$ acid digestion
ICP-OES-FUS	Inductively Coupled Plasma Optical Emission Spectrometry following lithium metaborate/tetraborate fusion
ICP-OES-HNO_3	Inductively Coupled Plasma Optical Emission Spectrometry following nitric acid digestion
ICP-MS-FUS	Inductively Coupled Plasma Mass Spectrometry following lithium metaborate/tetraborate fusion
ISE	Ion-selective electrode
LCL	Lower control limit
LOI	Loss-on-ignition
negative detection limit	Below detection limit
pct	Percent
ppm	Parts per million
Rec_Val	Recommended value
UCL	Upper control limit
wt_pct	Weight percent

(ppm). A negative number indicates that the concentration was below the detection limit (*e.g.*, -0.01 indicates the measured value was below the detection limit of 0.01). Detection limits are listed for each element in the .csv files.

Mg# was determined by the formula:

$$Mg\# = (MgO/40.312)/((MgO/40.312)+(FeO^T/71.847))*100.$$

Ishikawa Alteration Index (*see* Large *et al.*, 2001):

$$AI = 100*(K_2O + MgO)/(K_2O + MgO + Na_2O + CaO)$$

Chemical Index of Alteration (Nesbitt and Young, 1982):

$$CIA = [Al_2O_3/(Al_2O_3 + CaO* + Na_2O + K_2O)] *100$$

Within the Duplicates Table (Appendix B):

$$\%\_difference = [(OriginalValue - Lab\ Split\ Value)/Original\ Value] * 100.$$

ACKNOWLEDGMENTS

Chris Finch and the staff at the Geological Survey of Newfoundland and Labrador geochemical laboratory are thanked for their excellent work in obtaining the high-quality lithogeochemical data in a timely fashion. A. Mills was accompanied (and periodically assisted) by visiting geosci-

Table 2. Analytical methods for geochemical analyes

Element	Analytical Method	Preparation/Digestion
SiO_2, Al_2O_3, Fe_2O_3T, MgO, CaO, Na_2O, K_2O, TiO_2, MnO, P_2O_5, Ba, Be, Cr, Sc, Zr	Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)	50-50 Lithium Tetraborate Lithium Metaborate Fustion
FeO	Titration	NH_4VO_3, HF, H_2SO_4, $HSPO_4$
As, Cd, Co, Cu, Li, Mo, Ni, Pb, Rb, S, V, Zn	Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)	Hf-HCl-HNO_3-$HClO_4$ (total digestion)
Bi, Ce, Cs, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, La, Lu, Nb, Nd, Pr, Rb, Sm, Sn, Sr, Ta, Tb, Th, Ti, Tm, U, W, Y, Yb	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	50-50 Lithium Tetraborate Lithium Metaborate Fusion
F	Ion Selective Electrode (ISE)	Na_2CO_3 and KNO_3 fusion
Ag	Inductively Coupled Plasma Optical Emission Spectrometry ICP-OES)	HNO_3 digestion
LOI	Gravimetric (Grav) at 1000°C	None

entist Javier Alvaro for sampling on the Avalon Peninsula, and by colleague James Conliffe and assistant Noah Slaney on the Burin Peninsula. Thanks also go to Pauline Honarvar for a thorough review of the data for quality control.

REFERENCES

Ficklin, H.E.
1970: A rapid method for the determination of fluorine in rocks and soils, using an ion selective electrode. U.S. Geological Survey, Paper 700C, pages 186-188.

Finch, C., Roldan, R., Walsh, L., Kelly, J. and Amor, S.D.
2018: Analytical methods for chemical analysis of geological materials. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File NFLD/3316, 67 pages.

King, A.F.
1988: Geology of the Avalon Peninsula, Newfoundland (parts of 1K, 1L, 1M, 1N and 2C). Government of Newfoundland and Labrador, Department of Mines, Mineral Development Division, Map 88-01.

Large, R.R., Gemmell, J.B. and Paulick, H.
2001: The Alteration Box Plot: a simple approach to understanding the relationship between alteration mineralogy and lithogeochemistry associated with volcanic-hosted massive sulfide deposits. Economic Geology, Volume 96, pages 957-971.

McCartney, W.D.
1967: Whitbourne map area, Newfoundland, Geological Survey of Canada, Memoir 341, 135 pages.

Nesbitt, H.W. and Young, G.M.
1982: Early Proterozoic climates and plate motions inferred from major element chemistry of lutites. Nature, Volume 299, pages 715-717.

O'Brien, S.J., Nunn, G.A.G., Dickson, W.L. and Tuach, J.
1984: Terrenceville, Newfoundland (preliminary bedrock geology NTS sheet 1M/10). Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Map 84-59.

Strong, D.F., O'Brien, S.J., Taylor, S.W., Strong, P.G. and Wilton, D.H.
1977: Marystown, Newfoundland (preliminary bedrock geology NTS sheet 1M/03). Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Open File 1M/30/0172, Map 77-020.

Wilson, A.D.
1960: The micro-determination of ferrous iron in silicate minerals by a volumetric and a colorimetric method. Analyst, Volume 85, Issue 1016, pages 823-827.

APPENDICES

Appendices A–C are available as digital comma-separated files (.csv) through this link.

APPENDIX A: Major-element and Trace-element Data

APPENDIX B: Major-element and Trace-element Data for Duplicates

APPENDIX C: Major-element and Trace-element Data for Standards, with Certified Reference Materials