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Mines

**SATELLITE ALTERATION MAPPING AND GROUND
FOLLOW-UP SHORT WAVELENGTH INFRARED
STUDIES OF THE LONG HARBOUR GROUP,
AVALON ZONE (NTS MAP AREAS 1M/10
AND 11), NEWFOUNDLAND**

G.W. Sparkes and J.G. Hinchey

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SUMMARY

This open file contains the results of a pilot study utilizing WorldView-3 satellite data to evaluate the alteration mineralogy of a portion of the Long Harbour Group, within the Avalon Zone (NTS map areas 1M/10 and 11; Figure 1) of Newfoundland, which is, locally, host to both high- and low-sulphidation-style epithermal mineralization. The contract report related to the acquisition and interpretation of the satellite data, in addition to 177 ground-based follow-up short wavelength infrared (SWIR) spectral measurements, collected utilizing a TerraSpec® Halo spectrometer, are included within this database. Whole-rock geochemical results for 28 samples collected from select alteration zones highlighted by the satellite study are also included.

NOTES ON THE DATABASE

The Long Harbour Group, within the Avalon Zone of Newfoundland, is known to host several occurrences of both high- and low-sulphidation-style epithermal mineralization and related alteration (Sparkes, 2012; Sparkes and Dunning, 2014; and references therein). The presence of these occurrences, combined with the abundant outcrop exposure in the region (*see* area of interest in Appendix A), were used as factors in selecting this area for a satellite-alteration mapping study using WorldView-3 satellite data. This open file contains the contract report provided by Kongsberg Satellite Services (Appendix A), who oversaw the collection and interpretation of the satellite data in the fall of 2021. The related GIS files for individual mineral layers related to this report are provided in Appendix B. This study identified several zones of hydrothermal alteration within a pre-defined area of the Long Harbour Group. These anomalies were investigated by Geological Survey personnel, through ground-based studies in June of 2022. These studies utilized a TerraSpec® Halo spectrometer to obtain short wavelength infrared (SWIR) spectrometry measurements from outcrops proximal to the identified satellite anomalies.

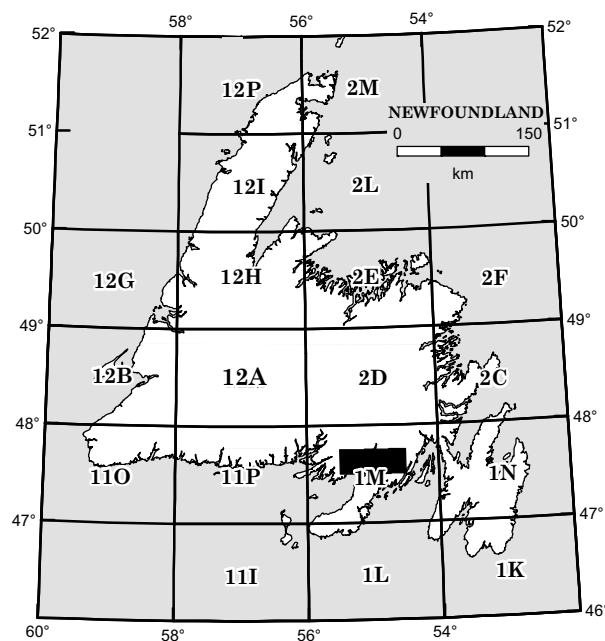


Figure 1. Location map of the study area in eastern Newfoundland.

Appendix C contains station location data and brief outcrop descriptions for the sites that were visited. Raw spectral files, as well as the interpreted mineral results for the ground-based spectral measurements, collected from these stations are presented in Appendices D and E, respectively. Appendix E includes location data for the individual spectra measurements along with the interpreted mineral results as provided by both the TerraSpec® Halo instrument and third party software (The Spectral Geologist (TSG™); version 8.1.0.5). The TerraSpec® Halo instrument provides up to seven minerals for each spectra with a star rating system for the identified minerals that indicates a prediction of confidence for the overall match of the spectra against an internal reference library; this ranges from 3 indicating a high level of confidence to 1 indicating a low

level of confidence. In addition, the TerraSpec® Halo also provides common calculated scalars based on the spectral measurements, these include: 1) Al-Fe-Mg, 2) Al-OH, 3) CSM, 4) Fe3i, 5) Fe3t, 6) Fe-OH, 7) ISM, 8) Kx, 9) Mg-OH. For a description of these scalars and how they are calculated refer to Malvern Panalytical Ltd. (2021). The interpreted mineral results provided by The Spectral Geologist (TSG™) include the two most dominant mineral phases present (TSG_Min1; TSG_Min2), estimated relative proportions of these mineral phases (TSG_Wt1; TSG_Wt2), and a corresponding error related to the overall ‘fit’ of the sample spectra relative to those in the TSG™ spectral database (TSG_Error; Appendix E). For these error values, the lower the number the better the match with reference spectra in the database. Values within the spectral results which include “Null” indicate no match was found within acceptable errors, and “Aspectral” values indicate poor quality spectral measurements.

Sample location data and a brief sample description for the 28 outcrop samples collected for geochemistry along with TSG™ results for spectral measurements collected from each sample are provided in Appendix F. Geochemical data for these samples are included in Appendix G. This includes major and select trace elements analyzed by inductively coupled plasma optical emission spectrometry following lithium tetraborate and metaborate fusion (ICP-OES-FUS). Loss-on-ignition (LOI) and ferrous iron (FeO) values are determined through gravimetric and titration methods, respectively (cf. Finch *et al.*, 2018). Select trace elements are also provided by ICP-OES following a four acid (HF-HCl-HNO₃-HClO₄) total digestion. The remaining trace elements are determined by ICP-MS after a four acid (HF-HCl-HNO₃-HClO₄) total digestion (ICP-MS-FUS). Fluoride values are provided by ion-selective electrode (ISE) analysis following alkaline fusion. Silver analyses are done through ICP-OES following a nitric acid digestion (ICP-OES-HNO₃). The procedure for external neutron activation analysis (NAA) is summarized in Finch *et al.* (2018); NAA data was obtained from the external commercial laboratory Bureau Veritas. Cold vapor mercury analyses was conducted at Actlabs (*see* details of the analytical procedure ‘1G’ at <https://actlabs.com/geochemistry/exploration-geochemistry/mercury>). Analytical duplicates are presented in Appendix H, and Appendix I includes the values for certified reference material values listed above each of the analysis that were included when the samples were analyzed. Finally, representative photographs of the 28 samples submitted for geochemistry are provided in Appendix J. The data is available in digital format (*i.e.*, *.csv, comma-separated value files) through the links provided in the Appendices.

The location data in this release is provided in Universal Transverse Mercator (UTM) eastings and northings, NAD 83 (Zone 21). Note that the negative value, -99, reported for a given sample indicates that a particular element was not analyzed for in the sample, whereas all other negative numbers indicate the concentration of the specific element in the sample was below the detection limit; major elements are reported in weight percent (wt_pct), and trace elements are reported in parts per million (ppm) or parts per billion (ppb). Detection limits are listed below each element in the table headers. A list of abbreviations used in the database is provided in Table 1.

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Table 1. List of abbreviated terms used in this release

Abbreviation	Explanation
-99	Sample was not analyzed for that element
DL	Detection limit
Dup	Duplicate analysis
Fe ₂ O ₃ T	Total measured iron
GSNL	Geological Survey of Newfoundland and Labrador
Grav.	Gravimetric
ICP-OES-FUS	Inductively Coupled Plasma Optical Emission Spectrometry: utilizes total digestion, lithium metaborate/tetraborate fusion technique
ICP-OES-4-ACID	Inductively Coupled Plasma Optical Emission Spectrometry: utilizes HF-HCl-HNO ₃ -HClO ₄ acid digestion
ICP-MS-FUS	Inductively Coupled Plasma Mass Spectrometry: utilizes total digestion, lithium metaborate/tetraborate fusion technique
NAA	Neutron Activation Analysis
INV	Invalid
ISE	Ion-selective electrode
LOD	Level of detection
LOI	Loss-on-ignition
N/A	Not available
Null	No match available
pct_diff	Percent difference
ppb	Parts per billion
ppm	Parts per million
Ref	Reference
Std.	Standard
wt_pct	Weight percent

processing and delivery of lithogeochemical data. Pauline Honarvar and staff of the Publications section are thanked for review and preparation of this open file release.

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APPENDICES

Appendices A–J are available in various formats through [this link](#).

APPENDIX A: Contract Satellite Mineral Study of the Long Harbour Area

APPENDIX B: GIS Files for Individual Mineral Layers Related to Appendix A

APPENDIX C: Station Location Data and Brief Outcrop Descriptions

APPENDIX D: Raw Ground Based Spectral Measurement Files

APPENDIX E: Interpreted Mineral Results for Ground-based Spectral Measurements

APPENDIX F: Sample Location Data and Brief Sample Descriptions for Geochemical Samples

APPENDIX G: Major-element and Trace-element Data

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

APPENDIX I: Major-element and Trace-element Data for Standards

APPENDIX J: Representative Sample Photographs