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SCANNING ELECTRON MICROSCOPE-MINERAL LIBERATION ANALYSIS (SEM-MLA) OF 6 BEDROCK THIN SECTIONS FROM THE HOPEDALE BLOCK (NTS MAP AREA 13N)

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INTRODUCTION

The Scanning Electron Microscope-Mineral Liberation Analyzer (SEM-MLA) produces false-colour, mineral distribution thin-section maps. The SEM-MLA software uses backscatter electron (BSE) imaging as a measure of average atomic number to determine grain boundaries, and employs both user-defined X-ray spectra and a library of X-ray spectra for known reference minerals to determine the identity of each mineral grain within a thin section (*e.g.*, Sylvester, 2012). Along with the thin-section maps, the spectra provide the user with an estimate on mineral mode abundances at the thin section scale. This report presents SEM-MLA results from six thin-bedrock sections collected from the Hopedale Block in northern Labrador. The rock samples were selected for their geochemistry and lithology (Table 1, Figure 1), for use in comparison to till mineralogy of the Hopedale Block. The mineral abundances from these thin sections also complement the results of geochemical analyses of rock samples presented in Open File LAB/1763 (Hinchey *et al.*, 2021). This Open File report presents the mineral-mode abundances as tables (Excel spreadsheets as .csv files; Appendix A), as well as the false-colour and BSE maps (Appendix B), and individual mineral scans and spectra (Appendix C).

METHODOLOGY

Rock sample locations are plotted in Figure 1 (Hinchey *et al.*, 2023). Samples were collected in the 2018 and 2019 field seasons from rock units of the Hopedale Block. These include a porphyritic volcanic rock from the Flowers River Igneous Suite (18HS-030B), a diorite from the Nain

Table 1. Thin section names and locations; rock lithology, regional bedrock, and geochemical and some geological highlights of the samples

Thin section sample ID	UTM East	UTM North	UTM Zone	Datum	NTS Map	Lithology (field ID)	Unit	Geological highlights
18HS030B	616891	6158654	20	NAD27	13N/11	quartz-K-feldspar phyric silicic metavolcanic	Flowers River Igneous Suite	Elevated F (4982 ppm)
19HS030B	604235	6143003	20	NAD27	13N/06	rusty pyritic diorite	Nain Plutonic Suite diorite	Elevated Zn (246 ppm), Ti (2.3%) and Cr (462 ppm)
18HS035A	601809	6138624	20	NAD27	13N/06	quartz syenite	Maggo gneiss, Weekes and Aucoin suite rocks	Anomalous Ce (682 ppm), Nd (363 ppm), Pr (88.9 ppm), Sr (3981 ppm), F (1275 ppm), and Ba (1.05%)
19HS002	621250	6118623	20	NAD27	13N/03	hornblende-clino-pyroxene-biotite-magnetite diorite	Harp Lake dyke	Geological interest-(lamprophyre). Olivine and phlogopite detected in optical microscopy
19HS040B	639032	6128245	20	NAD27	13N/07	rusty pyrrhotite-rich amphibolite	Hunt River Group	Zn (503 ppm), CD (2.7 ppm), Bi (detectable-0.6 ppm), Cu (289 ppm), Ni (254 ppm), Li (169 ppm) and Cs (8 ppm)
19HS005C	665260	6159053	20	NAD27	13N/09	pyrrhotite-rich	Maggo gneiss	Anomalous Cu (2565 ppm), Ni (2409 ppm), Co (896 ppm) and Se (32 ppm) (Hinchey *et al.*, 2021)

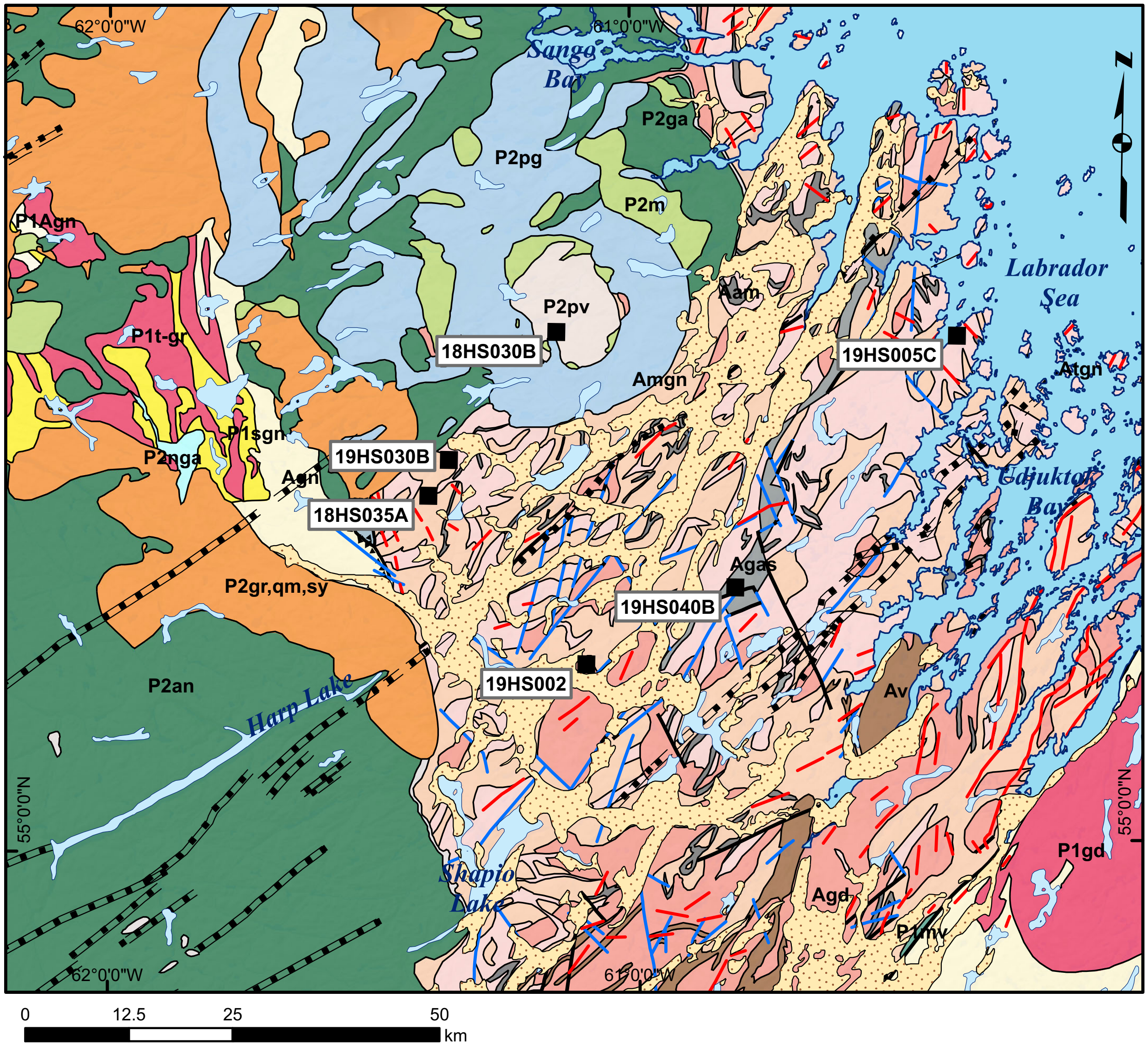

Figure 1. *Sample locations plotted over a recently updated map of the Hopedale Block (Hinchey* et al.*, 2023).*

Plutonic Suite (19HS-030B), a syenite from the Aucoin Suite (18HS-035A), a diorite dyke (Harp dyke?) that intrudes the Kanairiktok Plutonic Suite (19HS-002), amphibolite from the Hunt River Belt (19HS-040B) and an amphibolite raft (Weekes Amphibolite?) included in the Maggo gneiss (19HS-005C). Samples were selected for SEM-MLA analysis based on anomalous bedrock geochemical results (Hinchey, 2021); *e.g.*, sample 19HS-005C, with elevated nickel (2409 ppm), copper (2565 ppm) and cobalt (896 ppm), and sample 18HS-035A, with elevated rare-earth elements cerium (682.2 ppm), neodymium (363.4 ppm), lanthanum (278.2 ppm), praeseodynium (88.9 ppm), strontium (3981 ppm) and barium (10500 ppm), as well as their geology and distribution throughout the Hopedale Block (Table 1).

The thin sections were examined using transmitted light microscopy to identify some of the rock-forming minerals (*e.g.*, plagioclase, hornblende and orthopyroxene), and then with the

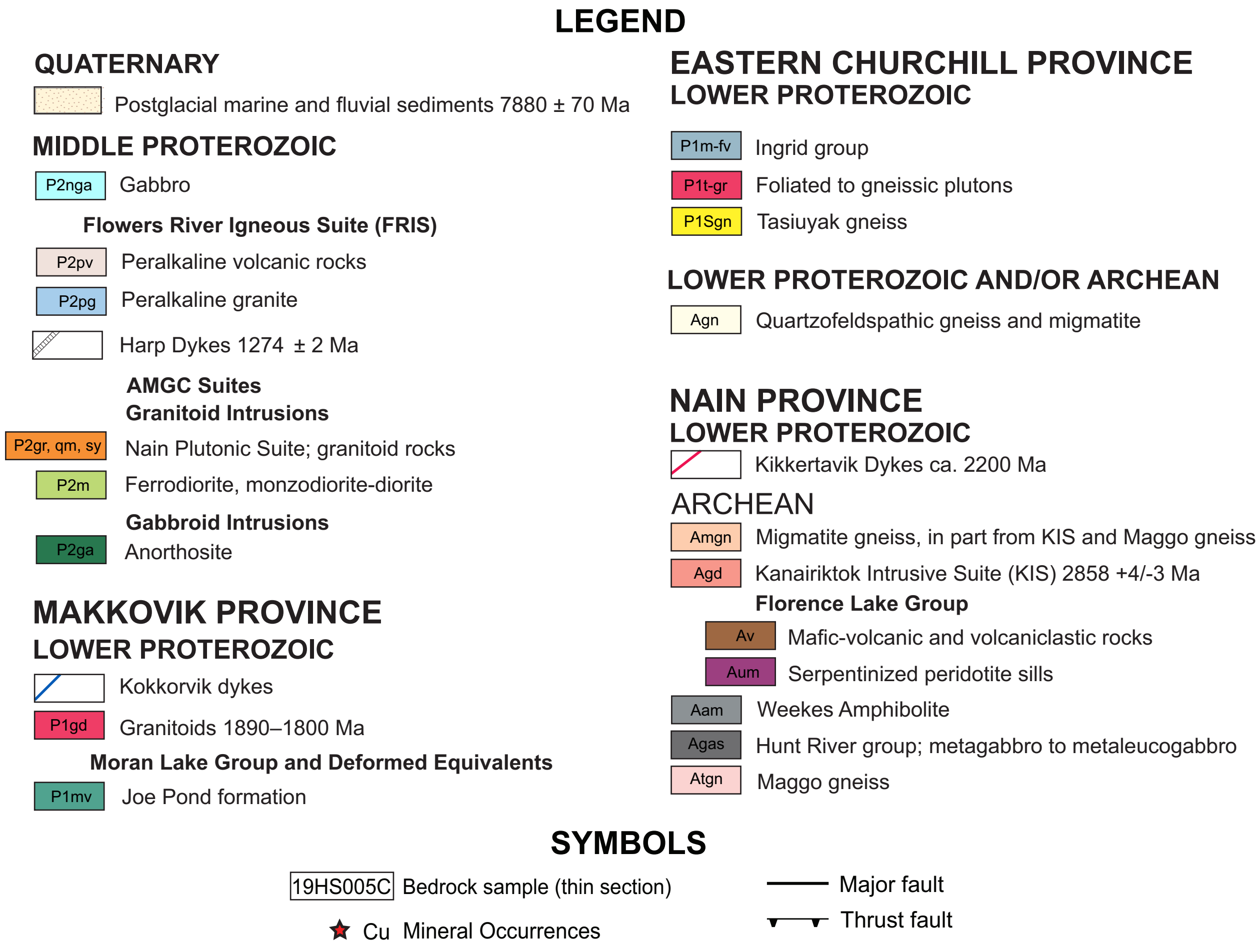

Figure 1. *Legend.*

reflected light microscope for opaque mineral phases (*e.g.*, chalcopyrite, pyrite and pyrrhotite). Minerals and textural areas of interest were identified and the thin sections were submitted for SEM-MLA scanning.

The carbon-coated thin sections were scanned by a FEI Quanta 400 environmental Scanning Electron Microscope (SEM) using an FEI (2014) MLA Suite 3.1 Product Version 3.1.5.703 operating system. The backscatter electron (BSE) variations were used to define mineral grain boundaries, and the energy-dispersive (EDX) scanning electron spectrum was used to map each mineral grain in the sample. The SEM collects BSE and EDX data by scanning the thin sections in frames (~250–300) and each frame is 2 mm x 2 mm, with a resolution of 400 x 400 pixels (Sylvester, 2012).

The spectra from the EDX scans were compared and matched to an in-house library of mineral spectra compiled from previous studies in the same region (*e.g.*, the Aucoin prospect – Sandeman and Rafuse, 2011; Sandeman and McNicoll, 2015) and from reference minerals (Sylvester, 2012). Individual mineral grains were scanned using multipoint analysis or mineral map scanning to provide semi-quantitative analysis of chemical variations within the grain.

ANALYTICAL LIMITATIONS

Distinguishing the elemental peaks from the EDX analysis, particularly at low elemental concentrations and small grain size, can be difficult (*e.g.*, Sylvester, 2012; Layton-Matthews *et al.*, 2014; Schulz *et al.*, 2019). Smaller scale energy dispersive spectroscopy (EDS) analyses of select minerals are provided in Appendix C; however, small grains require analysis by electron microprobe (Reed, 2005) to accurately determine their composition. Therefore, the elemental data provided in Appendix C should be treated as semi-quantitative. Errors for the individual mineral analyses are provided with the .txt and Excel spreadsheets included in Appendix C.

The automatic identification of mineral phases requires a comparative library of mineral spectra that have been previously identified in a region. For this study, a library specific to the Aucoin Suite in the Hopedale Block of central-north Labrador (Sandeman and Rafuse, 2011; Sandeman and McNicoll, 2015) was used. Two of the samples were collected there, and the Aucoin spectral library contained all of the optically observed mineral species in the sections. During the scanning process, minerals that were unidentifiable using automatic scanning were labelled “Unknown”. These are included in the spreadsheets and are represented in black on the SEM–MLA maps. The largest “Unknown” was a mica mineral that was later identified as annite after examining the spectra from the mineral using the SEM spot feature. After identifying this unknown phase, it was added to the mineral library and the samples were re-classified, thereby reducing the “Unknown” content in the scans to areas where uncertainty (0–0.06 % of the total samples) would be expected (*e.g.*, edges of thin sections, voids).

In addition to “Unknown” grains, there are regions of the thin section that are not analyzed (No_Xray in spreadheets), and include the holder (Al-holder), the thin-section slide (Glass Slide) or, have low counts (Low_Counts). All of these sources of error have been examined (Table 2) to determine if they are significant (*e.g.*, a large proportion of the sample). None of the sources of error are above 0.06% of the total mapped area of each sample, and the only sources of error above 0.01% were Unknown minerals (sample 19HS-030B and 19HS-040B) and Glass Slide (sample 18HS-030B). Sample 19HS-030B indicated a barium-rich, iron-silicate-sulphur-bearing mineral (Appendix C; anandite? zingruvanite? Mindat.org, Januray 22, 2023; https://www.mindat.org/chemsearch.php?inc=Ba%2CSi%2CS%2CFe%2C&exc=&class=0&sub=Search+Minerals) that might explain the 0.04 % of unknown material detected in this sample.

Sample 19HS-040B had the highest unknown mineral content, at 0.06%, but because of the fine-grained matrix (Appendix B), the locations of the unknown minerals were difficult to identify. Small grains (~5–10 µm) of base-metal tellurides and alloys were detected by targeted SEM scans of individual regions. Sufficient quantities of these minerals could explain the unknown minerals in the sample, as well as some of the elevated base-metal geochemical values (Table 1).

SUMMARY

The new SEM–MLA data from rocks in the Hopedale Block, Labrador, provide mineral grain mode information that can be used in a number of ways. Here, the data provide confirmative visual and semi-quantitative EDS analyses on grain abundances, and Ni–Cu–Co and REE-bearing

Table 2. Sources of error in grain determinations (red). A reason for the error is provided in the last column of the table

	Area %	Area (micron)	Grain Count	Total Sample Area (micron)	Total Grain Count	Reason for Error
Unknown						
18HS-030B	0.01	116848.21	3	789225701.32	434818	Very fine grain size in this sample; hard to locate the three unknown grains
19HS-030B	0.04	383239.45	6	887849037.10	338006	Unknown grains of barium silicate defined in sample
18HS-035A	0.00	20059.66	1	978400181.06	466960	
19HS-002	0.00	0.00	0	1107937481.81	320212	
19HS-040B	0.06	655498.30	11	1155941001.41	296259	Very fine grain size in this sample; hard to locate the grains. Small grains of base-metal alloys and tellurides?
19HS-005C	0.00	0.00	0	1103975693.94	220611	
Glass Slide						
18HS-030B	0.02	119251.05	3	789225701.32	434818	Volcanic sample - spherules and gas bubbles would create voids that expose the glass slide throughout the thin section
19HS-030B	0.00	39462.37	1	887849037.10	338006	
18HS-035A	0.00	0.00	0	978400181.06	466960	
19HS-002	0.00	0.00	0	1107937481.81	320212	
19HS-040B	0.00	0.00	0	1155941001.41	296259	
19HS-005C	0.00	0.00	0	1103975693.94	220611	
Low_Counts						
18HS-030B	0.00	1349.91	4	789225701.32	434818	
19HS-030B	0.00	395.97	6	887849037.10	338006	
18HS-035A	0.00	6911.54	14	978400181.06	466960	
19HS-002	0.00	1718.89	1	1107937481.81	320212	
19HS-040B	0.00	24910.34	30	1155941001.41	296259	
19HS-005C	0.00	12374.18	13	1103975693.94	220611	
No_XRay						
18HS-030B	0.00	395.97	25	789225701.32	434818	
19HS-030B	0.00	2816.81	177	887849037.10	338006	
18HS-035A	0.00	314.98	22	978400181.06	466960	
19HS-002	0.00	350.98	28	1107937481.81	320212	
19HS-040B	0.00	665.96	47	1155941001.41	296259	
19HS-005C	0.00	13544.10	87	1103975693.94	220611	
Al-holder						
18HS-030B	0.00	0.00	0	789225701.32	434818	
19HS-030B	0.00	0.00	0	887849037.10	338006	
18HS-035A	0.00	0.00	0	978400181.06	466960	
19HS-002	0.00	116.99	1	1107937481.81	320212	
19HS-040B	0.00	14255.05	1	1155941001.41	296259	
19HS-005C	0.00	0.00	0	1103975693.94	220611	

phases present in the bedrock samples containing anomalous geochemistry. Moreover, these results provide insight into the mineral potential of some of the rock types in the Hopedale Block, and the data will be used for comparison to indicator minerals in till in an upcoming report.

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APPENDICES

Appendices A–C are available in various formats in .zip files through this link.

APPENDIX A: Excel Spreadsheets (.csv format) of SEM-MLA Mineral Mode Data

APPENDIX B: SEM-MLA and BSE Images of the Thin Sections

APPENDIX C: Miscellaneous EDS Mineral Spectra, Semi-quantitative Elemental Data and Images