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M.B. McClenaghan[1], G. Budulan[2], S.A. Averill[3], D. Layton-Matthews[2], and M.A. Parkhill[4]

[1]Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8
[2]Queen's University, Department of Geological Sciences and Geological Engineering, Kingston, Ontario K7L 3N6
[3]Overburden Drilling Management Ltd., 15 Capella Court, Unit 107, Ottawa, Ontario K2E 7X1
[4]New Brunswick Department of Natural Resources, Geological Surveys Branch, P.O. Box 50, Bathurst, New Brunswick E2A 3Z1

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INDICATOR MINERAL ABUNDANCE DATA FOR THE BEDROCK AND TILL SAMPLES FROM THE HALFMILE LAKE ZN-PB-CU VOLCANOGENIC MASSIVE SULPHIDE DEPOSIT, BATHURST MINING CAMP, NEW BRUNSWICK

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ABSTRACT

Till and bedrock samples were collected from and around the Halfmile Lake Zn-Pb-Cu volcanogenic massive sulphide (VMS) deposit in northern New Brunswick to determine their indicator minerals and trace element signatures that are indicative of VMS deposits. The purpose of this open file is to report the raw indicator mineral abundance data for bedrock and till samples collected in 2007 and 2008 for this case study. Till and bedrock samples were processed by the commercial lab Overburden Drilling Management Limited using a combination of tabling, panning, and heavy liquids to recover potential indicator minerals. Sample locations, weights of various fractions produced during sample processing, and indicator mineral grains identified are reported in this open file.

INTRODUCTION

Several case studies have been published that document the indicator mineral signatures for a broad range of mineral deposit types in till, however, few have been published that document indicator mineral signatures of volcanogenic massive sulphide (VMS) deposits. To address this knowledge gap, the Geological Survey of Canada (GSC), through its Targeted Geoscience Initiative 3 Program (2005-2010), in collaboration with the New Brunswick Department of Natural Resources (NBDNR) and Queen's University collected and analyzed a suite of till and bedrock samples from and around the Halfmile Lake Zn-Pb-Cu VMS deposit (Fig. 1) in northern New Brunswick (Budulan et al., 2009). The Halfmile Lake deposit was chosen as a VMS test site because (1) the deposit geology is well known and bedrock samples were available from drill core; (2) the deposit subcrops and thus it was exposed to glaciation; (3) the deposit is till covered; (4) the area is easily accessible; (5) previous regional- and local-scale till sampling identified an east-northeastward–trending glacial dispersal train of geochemically anomalous till extending down-ice from the Halfmile Lake deposit (Parkhill and Doiron, 2003).

The specific objectives of this indicator mineral study are (1) to determine the indicator minerals and their trace element signatures that are indicative of VMS deposits; and (2) to establish practical methods for their recovery from glacial sediments and their identification that can be routinely applied in VMS exploration in glaciated terrain. Samples of bedrock and till were both collected for this study. The purpose of this open file is to report the raw indicator mineral abundance data for bedrock and till samples collected in 2007 and 2008 for this case study. Interpretations of these indicator mineral data, as well as till geochemical data for the <0.063 mm fraction of the same till samples, will be published in subsequent GSC Open Files.

METHODS

Field Sampling

Till and bedrock samples were collected in July 2007 in the vicinity of the Halfmile Lake deposit. Bedrock samples (1-10 kg) were collected to document the indicator mineral signatures of the host rocks and their mineralization for comparisons with the mineralogy and geochemistry of the till. Bedrock sample locations are listed in Appendix A.

A total of 55 large (25 kg) till samples were collected up-ice, in the vicinity of and at 0-10, 200, 400, and 800 m down-ice (east) of the South Upper AB zone of the deposit. Background till samples were collected at 300 and 600 m up-ice. Till sample distribution in 2007 was guided by known till geochemical patterns reported by Parkhill and Doiron (2003). In 2008, an additional 20 till samples were collected up to 10 km up-ice and 20 km down-ice to further document the distribution of specific indicator minerals found in the 2007 till samples. Till sample locations are listed in Appendix A.

Till samples were collected from hand-dug holes and backhoe trenches. Hand-dug holes were used at till sample sites up-ice and far down-ice of the Halfmile Lake deposit because this method is cost effective and

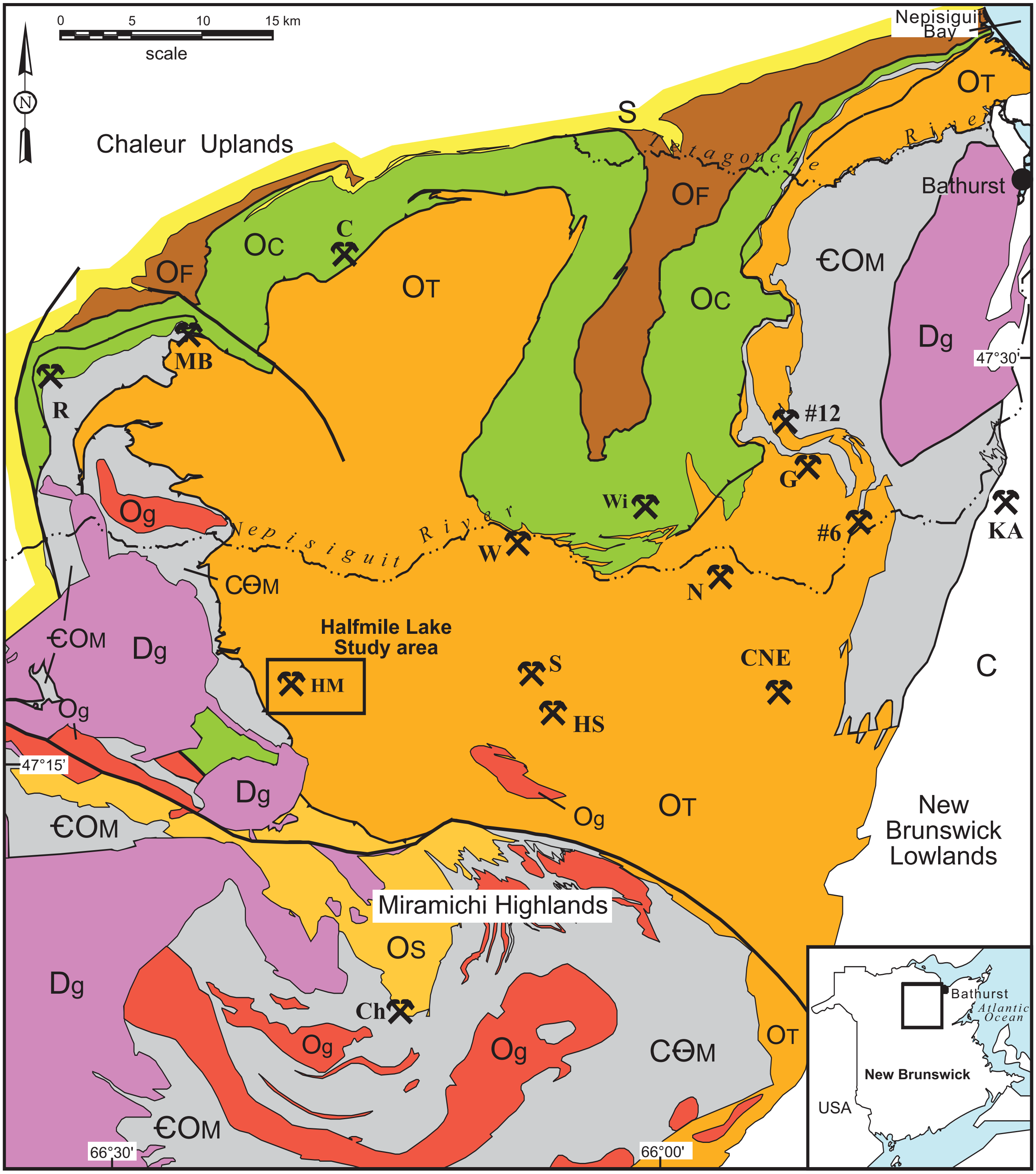

Figure 1. Location of the Halfmile Lake deposit in north central New Brunswick showing regional bedrock geology (modified from Parkhill and Doiron, 2003). Bedrock legend: C = Carboniferous sedimentary rocks; Dg and Og = Devonian and Ordovician (mainly felsic) intrusive rocks, respectively; Є-OM = Cambrian-Ordovician sedimentary rocks of the Miramichi Group; OF = Ordovician mafic volcanic and sedimentary rocks of the Fournier Group; OT, OC, and OS = Ordovician sedimentary, felsic, and mafic volcanic rocks of the Tetagouche, California Lake, and the Sheephouse Brook groups, respectively; S = Silurian and younger rocks. Crossed-hammer symbol indicates significant VMS deposits: C = Caribou; Ch = Chester; CNE = Captain North Extension; F = FAB; G = Grandroy; HM = Halfmile Lake; HS = Heath Steele; KA = Key Anacon; MB = Murray Brook; N = Nepisiguit Brook; No. 6 = Brunswick 6; No. 12 = Brunswick 12; R = Restigouche; S = Stratmat; W = Wedge; Wi = Willett.

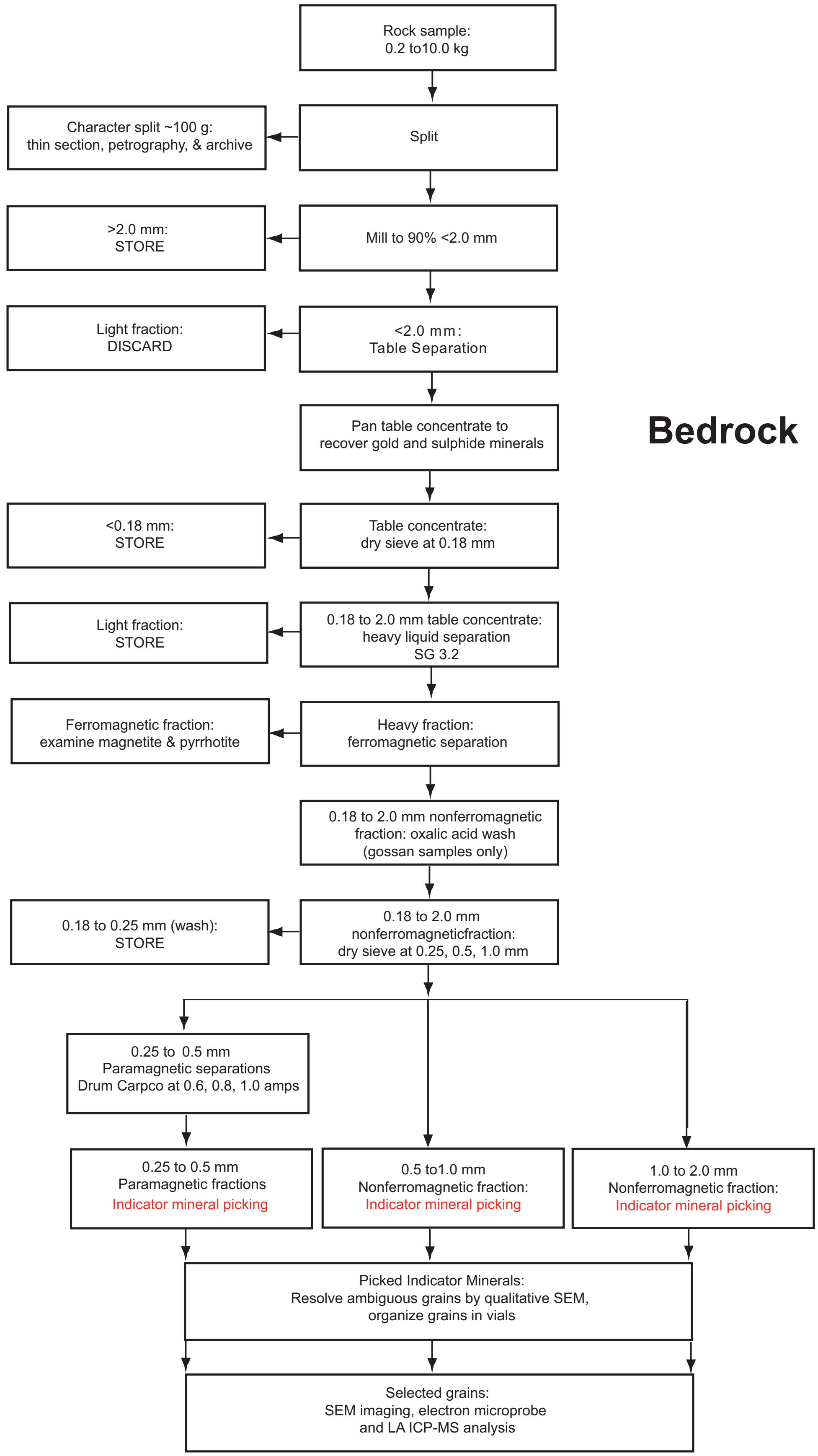

Figure 2. Flow sheet outlining the sample processing and picking procedures used for bedrock samples at Overburden Drilling Management Limited.

the pits can be dug by hand to depths of more than 0.75 m into less oxidized till. A wheeled backhoe was used to dig new trenches at sites close to the deposit where the till was thicker (up to 2 m) and samples were taken at smaller intervals. Till samples were also collected after clearing sections in the walls of existing exploration trenches close to the deposit. Till samples were collected from the B-C or preferably C soil horizons developed on till, which are less oxidized. Detailed notes and photos were taken at each sample site. Till sample depths are included in Appendix A. Three field duplicate samples were collected in 2007 to assess field variability: samples 07-MPB-007 and -011, 07-MPB-023 and -030, and 07-MPB-049 and -053.

Sample Processing and Indicator Mineral Picking

A split of 30 bedrock samples was shipped to Overburden Drilling Management Limited (ODM), Ottawa for processing and production of heavy mineral concentrates. Prior to crushing, bedrock samples were examined under a binocular microscope and described by ODM. Samples were processed such that the most mineralized samples were processed last to limit carry-over contamination of ore minerals between samples. Samples are listed in the ODM raw data files in Appendix B in the order in which they were processed at ODM.

Twenty-four weakly to non-mineralized bedrock samples (0.9-8.2 kg) were crushed to <2.0 mm at ALS Chemex Labs. Five, small (0.2-0.5 kg) mineralized bedrock samples (sample numbers 07-MPB-20, -R21, -R23, -R25,-R26) were crushed to approximately <2.0 mm at ODM using a small plate crusher. The <2.0 mm material of each bedrock sample was then processed at ODM to produce a nonferromagnetic heavy-mineral concentrate for picking indicator minerals, as outlined in Figure 2, and weights for all the fractions that were produced are reported in Appendix B. The <2.0 mm material was micropanned to recover gold and sulphides. The minerals in the panned concentrates were counted, their size and shape characteristics recorded, and then returned to the sample. The heavy table concentrate was then sieved at 0.18 mm. The 0.18 to 2.0 mm preconcentrate was then further refined using heavy liquid separation in methylene iodide diluted to a specific gravity (SG) of 3.2. The <0.18 mm table concentrate was further refined using a combination of tabling and heavy liquids and then stored.

The ferromagnetic fraction, including magnetite and pyrrhotite, was then separated using a hand magnet. The nonferromagnetic heavy mineral fraction was sieved into four size fractions: 0.18-0.25, 0.25-0.5, 0.5-1.0, 1.0-2.0 mm. The 0.18-0.25 mm fraction was archived and the 0.25-0.5 mm fraction was subjected to paramagnetic separations using a Carpco® magnetic separator at 0.6, 0.8, and 1.0 amps to assist picking this fine-grained fraction.

Till samples were also shipped to ODM for processing, production of heavy mineral concentrates, and indicator mineral picking. Similar to the bedrock samples, the <2.0 mm till fraction was processed to produce a nonferromagnetic heavy-mineral concentrate for selection of indicator minerals, as outlined in Figure 2, and weights for all fractions produced are reported in Appendix B. First, the <2.0 mm material was passed over a shaking table and the heavy table concentrate recovered and micropanned to recover gold and sulphides in the <0.25 mm fraction. The minerals in the panned concentrates were counted, their size and shape characteristics recorded, and then returned to the sample. Concentrates were then sieved at 0.25 mm. The 0.25 to 2.0 mm preconcentrate was then further refined using heavy liquid separation in methylene iodide diluted to a SG of 3.2. After panning and heavy liquid separation, the >0.25 mm ferromagnetic fraction was then removed and the nonferromagnetic heavy-mineral fraction was sieved into three size fractions: 0.25-0.5, 0.5-1.0, 1.0-2.0 mm. The <0.25 mm fraction of till for all samples was archived. The 0.25-0.5 mm fraction was further subjected to paramagnetic separations using a Carpo® magnetic separator to produce <0.6 amp (strongly paramagnetic), 0.6 to 0.8 amp (moderately paramagnetic), 0.8 to 1.0 amp (weakly paramagnetic), and >1.0 amp (nonparamagnetic fractions) to assist counting and picking indicator minerals in this fine-grained fraction. The 0.25-0.5 mm fraction was cleaned with oxalic acid to remove oxidation stains (tarnish) from the grains and restore their natural colour, which is most important for identifying sulphide minerals.

The 0.25-0.5, 0.5-1.0, and 1.0-2.0 mm nonferromagnetic fractions of bedrock and till samples were examined by ODM and indicator minerals counted/selected, including gold and sulphide mineral grains as well as potential oxide and silicate indicators of massive sulphide deposits. ODM's magmatic or metamorphosed massive sulphide indicator mineral (MMSIM®) suite is an indicator mineral assemblage used to explore for a broad spectrum of sulphide-associated deposits, including VMS deposits (Averill, 2001). The abundance of grey, specular, and red earthy hematite grains in the 0.25-0.5 mm nonferromagnetic heavy-mineral fraction was estimated for each till sample and a selection of grains set aside for further study. The 0.25-05 mm ferromagnetic fraction of the 2007 till samples was visually scanned to determine the abundance of pyrrhotite. A selection of picked grains was then analyzed by electron microprobe (EMP).

The digital data files reported by ODM consist of several worksheets for each of the three batches of

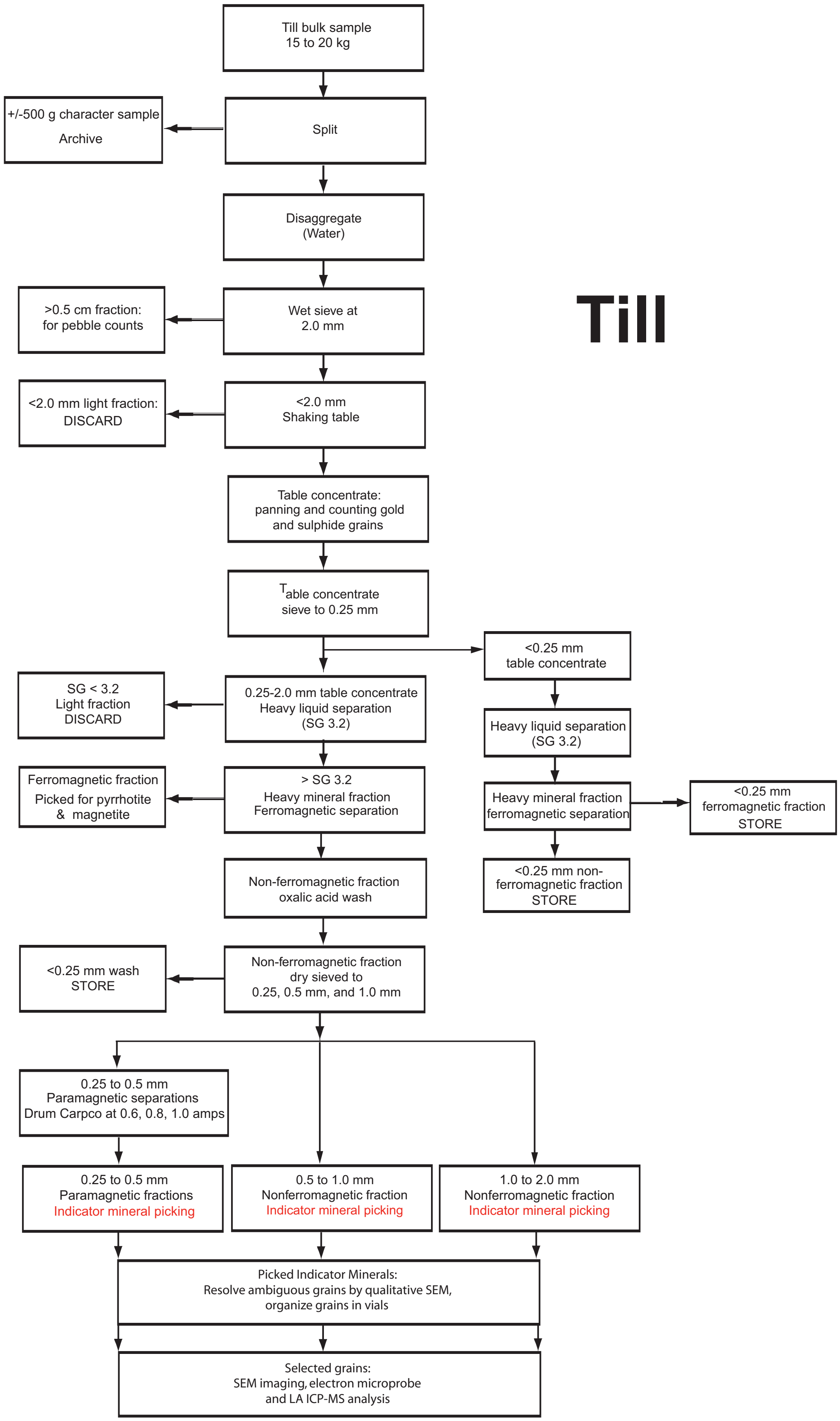

Figure 3. Flow sheet outlining the sample processing and picking procedures used for till samples at Overburden Drilling Management Limited.

samples processed: (1) 2007 till samples (Appendix B1), (2) 2008 till samples (Appendix B2), and (3) 2007 bedrock samples (Appendix B3). For both of the till batches, the weights of the fractions produced during sample processing are reported in four worksheets: "Tabling Data", "Weights", "Paramag" (weights for the paramagnetic fractions), and "TC weight" (<0.25 mm table concentrate weights). For bedrock samples, the weights of the fractions produced during sample processing are reported in four worksheets: "Crushing log" "Weights", "Paramag" (weights for the paramagnetic fractions), and "TC weight" (<0.25 mm table concentrate weights). Gold-grain data are reported in two worksheets: "Gold summary" and "Detailed VG", which describe the abundance, size, and shape of the visible gold and sulphide grains observed during panning. Indicator minerals (0.25-2.0 mm in size) of massive sulphide deposits are listed in worksheets "MMSIM" and "Additional grains" (pyrrhotite in the ferromagnetic fraction). Hematite grain counts are reported in the "Hematite Grains" worksheet.

Note that the concentrates for till samples 08-MPB-011 and -012 were inadvertently combined during sample processing at ODM. Approximately 30% (12.3 g) of the heavy mineral fraction from sample 08-MPB-012 was combined with the entire heavy mineral fraction (4.1 g) of sample 08-MPB-011. The combined heavy mineral fraction (16.4 g) was processed and picked as sample 08-MPB-011/012. The intact portion (27.5 g) of the heavy mineral fraction from sample 08MPB-012 was processed and picked as sample 08MPB-012I. Weight and picking data for these two affected samples are reported with these revised sample numbers in worksheets "Weights", Paramag", "MMSIM", and "Hematite".

Note that sample 08-MPB-021 is weathered Silurian-Devonian granite (grus) of the South Nepisiguit River Plutonic Suite (Wilson, 2007) collected in the Miramichi Highlands. The material is unconsolidated and has the appearance of well sorted beach sand. It does not contain any precious or base metal indicator minerals. Because of its ease of access, consistent nature and large area of outcrop this material was bulk sampled and will be used as a GSC in house 'blank' sample to monitor quality control during sample processing for the recovery of indicator minerals.

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