Industry, Energy and Technology

Mines

HUMUS AND TILL GEOCHEMISTRY IN THE VICINITY OF Au MINERALIZATION IN NEWFOUNDLAND: RESULTS FROM GLOVER ISLAND (NTS 12A/12 AND 13), JACKSON'S ARM (NTS 12H/15) AND NIPPERS HARBOUR (NTS 2E/13) MAP AREAS

S. Hashmi

Open File NFLD/3458

St. John's, Newfoundland
November, 2024

NOTE

DISCLAIMER

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:
Hashmi, S.
2024: Humus and till geochemistry in the vicinity of Au mineralization in Newfoundland: Results from Glover Island (NTS 12A/12 and 13), Jackson's Arm (NTS 12H/15) and Nippers Harbour (NTS 2E/13) map areas. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Open File NFLD/3458, 55 pages.

CONTENTS

Page

FIGURES

PLATES

TABLES

ABSTRACT

A humus- (decomposed vegetation; O-horizon) and till-sampling survey targeting select Au mineralization was completed on the island of Newfoundland in 2022. The objective of this survey is to test whether humus could reflect the geochemistry of the underlying till and/or bedrock near Au mineralization, and therefore, could be used as an alternate sampling medium. An ancillary objective of this project was to determine whether contaminants, such as anthropogenic airborne particulate matter, may have affected humus geochemistry. A total of 76 humus and 8 till samples were collected in the vicinity of known Au mineralization at three study sites, consisting of the Jackson's Arm (NTS 12H/15), Nippers Harbour (NTS 2E/13) and Glover Island (parts of Corner Brook, 12A/13 and Little Grand Lake, 12A/12) map areas. These sites were chosen because they contain well-known Au mineralization including the Rattling Brook Au deposit in the Jackson's Arm map area, Au and PGE mineralization in the Nugget Pond Au and the Betts Cove PGE deposit in the Nippers Harbour map area, and volcanic-hosted Au on Glover Island. Further, historic mining and ore processing operations in the Nippers Harbour map area also make it an ideal site to test whether anthropogenic activities may have had an influence on the humus geochemistry of the region.

Humus development correlates positively with loss-on-ignition (LOI) values; this provides a quantitative measurement of the quality of the sample and potential contamination by mineral soil or anthropogenic contamination by inorganic particulate matter. Humus is moderately to well-developed in the Jackson's Arm map area and contains 67–98% organic matter. Humus samples in the Nippers Harbour map area are poorly to moderately developed and contain 72–98% organic matter. Humus samples on Glover Island are generally well developed and the LOI% ranges 74–99%. The LOI content and humus development suggests that overall, Glover Island contains the most well-developed, organic-rich O-horizon with minimal anthropogenic fall out or mineral matter.

Spearman correlation matrices were generated for the three sites to determine element correlation. A correlation of greater than 0.7 ($r^2 > 0.7$) was considered a significant positive correlation. In the Jackson's Arm map area, Au in humus samples digested by aqua regia and analyzed by inductively coupled plasma-mass spectrometry (ICP-MS) do not show a significant correlation with any other element. Proportional dot plots showed spatial relationship between known Au occurrences and element distribution in the collected surficial samples. For the proportional dot plots, <50^{th} %ile is defined as background element content, 50^{th}–75^{th} %ile is defined as elevated content, 76^{th}–90^{th} %ile is defined as anomalous content and >90^{th} %ile is defined as highly anomalous content. In the Jackson's Arm map area, proportional dot plot maps show that at the Shrik, Stocker and Boot n Hammer Au occurrences, humus samples having anomalous to highly anomalous Au also contained elevated to highly anomalous Ag, As, Bi, Cu, Mo, Ni, Pb, S, Sb, Sn, Te and Zn. At the Rattling Brook Au deposit, samples with anomalous to highly anomalous Au also contained elevated to highly anomalous Ag, As, Co and Mo. Similarly, in the Nippers Harbour map area, Au in humus samples digested by aqua regia *and analyzed by ICP-MS do not show a significant correlation with any other element. However, proportional dot plot maps show that samples having anomalous to highly anomalous Au content also have anomalous to highly anomalous Ag, As, Cr, Cu, In, Mo, Ni and Pd. At Glover Island, Au by* aqua regia *ICP-MS shows a significant positive correlation with Se, Te, S, Ge and Sr. Proportional dot plot maps also show that samples having anomalous to highly anomalous Au content also have anomalous to highly anomalous As, Bi, Co, Cd, Cr, Hg, Mo, Ni, Pb, Pd, Pt, S, Sb, Se, Sn, Te and Zn.*

Up to 0.268 ppm Au, 36 ppm Ag, 0.008 ppm Pt and 0.009 ppm Pd are present in humus samples collected in the Jackson's Arm map area. Up to 0.686 ppm Au, 21 ppm Ag, 0.049 ppm Pt and 0.015 ppm Pd is recovered from humus samples collected on Glover Island, and up to 0.099 ppm Au, 7.3 ppm Ag, 0.007 ppm Pt and 0.01 ppm Pd is present in humus samples collected in the Nippers Harbour map area.

At all three study sites, till samples collected in the vicinity of Au occurrences contain elevated to highly anomalous Au (up to 0.371 ppm by fire assay), Ag (up to 0.44 ppm) and Pt (up to 0.003 ppm). Gold in the <63 µm till fraction, in a 50 g aliquot analyzed by aqua regia *ICP-MS, generally returned higher contents compared to the <10 µm till fraction, whereas Ag, Pt and Pd in the <10 µm till fraction, analyzed by* aqua regia *ICP-MS returned the highest contents relative to the 63 µm till fraction.*

Of the three sites sampled for this study, it is unlikely that anthropogenic particulate matter contributes significantly to the geochemical signature of humus in the Jackson's Arm map area nor Glover Island. Inorganic matter may have affected the geochemical signature of humus in the Nippers Harbour map area, where there has been historic mining activity in the region; however, detailed sampling needs to be completed in the region to determine the extent of anthropogenic contamination.

The results of this study demonstrate that humus can be an excellent sampling medium for Au exploration in Newfoundland, particularly in areas with concealed bedrock and little anthropogenic contamination. Humus is abundant and light weight, thereby allowing sampling personnel to cover a large area in a short amount of time. Analysis is relatively simple and low cost, returning high-quality data for concentrations of Au (at parts per trillion; ppt) and other noble metals such as Ag, Pd and Pt (at parts per billion; ppb).

INTRODUCTION

The island of Newfoundland has many Au deposits (Sandeman, 2014; Honsberger *et al.*, 2019; Conliffe, 2021; Westhues, 2022) and numerous Au occurrences (*see* GSNL, 2023a). However, the lack of unweathered till ("C-horizon soil developed in till") that is suitable for sampling, and the concealment of bedrock by vegetation and sediment has made grassroots exploration targeting Au mineralization challenging in some areas. Also, parts of the island were below the glaciomarine limit during deglaciation (Liverman, 1994; Hashmi, 2020), which means tills in these regions may have been modified by postglacial deposition processes that have affected the till-geochemical signature. To test the efficacy of an alternate surficial medium that can reflect the geochemical signature of the underlying soil and bedrock, the Geological Survey of Newfoundland and Labrador conducted a pilot study using humus to detect Au mineralization in bedrock in areas where till is either thin or absent.

BACKGROUND

Humus (O-horizon, above the mineral soil) is decomposed organic matter formed through humification, the process of oxidation, disintegration, and decay of vegetation and other organic materials (Kauranne *et al.*, 1992). Humus contains humic- and fulvic-acid complexes that can scavenge and adsorb metals from both geogenic and anthropogenic sources. Tree and shrub roots can absorb and translocate trace elements from deeper soil or underlying bedrock, which are then concentrated in the humus layer during subaerial decomposition (Rogers and Dunn, 1993). Therefore, the chemical composition of humus should be influenced by the underlying soil and bedrock, including its signatures of mineralization or dispersal.

Humus has been used successfully to delineate the geogenic, geochemical signature of precious and base-metal mineralization in or near mining camps in New Brunswick (*e.g.*, Au, Pb–Zn and Ni–Cu mineralization; Hall *et al.*, 2003) and Ontario (*e.g.*, Au mineralization; Dunn, 1998; McClenaghan *et al.*, 1998; Bajc and Hall, 2000; Hashmi, 2018; Table 1). Therefore, it is also likely to be well suited as a sampling medium in the glaciated boreal forest of Newfoundland because it is abundant, well developed, and likely relatively unaffected by airborne contamination due to low population density and sparse infrastructure development. Moreover, advancements in the field of analytical chemistry have enabled the detection of Au at parts per trillion (ppt) levels (Leybourne and Cameron, 2010), which enhances the signal to noise ratio between background and anomalous element content and facilitates recognition of subtle regional Au anomalies that might remain undetected by standard analytical packages.

OBJECTIVES

The primary objective of this study is to determine if the geochemical signature of Au mineralization and its associated elements such as Ag, As, Bi, Br, Cd, Hg, Mo, Pb, Sb, Se, Te and Zn (Fortescue, 1985; McClenaghan *et al.*, 1998) can be detected in humus. A secondary objective is to determine whether humus development and its geogenic geochemical signature are affected by the proximity to urban development, construction sites, areas of historic exploration, and/or mining activity. Ultimately, the goal of this study is to develop a practical workflow (field and analytical) that can assist explorationists in conducting large-scale grassroots exploration surveys targeting Au mineralization using humus as a sample medium in regions with little to no bedrock exposure or till (or in areas where till is affected by marine incursion).

Three study areas were selected for this study: Jackson's Arm (NTS 12H/15), Nippers Harbour (NTS 2E/13) and Glover Island (parts of Corner Brook, NTS 12A/13 and Little Grand Lake, NTS 12A/12). There are several Au occurrences in each study area that have been explored historically or are currently being explored. Sampling sites in these study areas were chosen based on the following prerequisites: 1) they are proximal (within a few kilometres) to known Au bedrock mineralization characterized by the presence of Au pathfinders such as As, Bi, Sb and Pb (Conliffe, 2021) or soil samples that

Table 1. Summary table of regional geochemical sampling programs that have successfully tested the suitability of humus as a viable sampling medium for greenfields mineral exploration targeting Au, PGEs and base metals

Location	Study area	Mineralization	Au (ppb)	Ag (ppb)	Pt (ppb)	Pd (ppb)	Cu (ppm)	Ni (ppm)	Reference
Newfoundland	Jackson's Arm	Au	268	36000	8	9	855	161	This study
Newfoundland	Nippers Harbour	Au	99	7300	7	10	1420	2950	This study
Newfoundland	Glover Island	Au	686	21000	49	15	5820	190	This study
Ontario	Timmins	Au	443	3666	NA	NA	586	60	McClenaghan *et al.*, 1998
Manitoba	Flin Flon	Cu–Zn–Au–Ag	NA	7600	NA	NA	3820	169	McMartin *et al.*, 1996
Ontario	Sudbury North Range	Ni–Cu–PGE–Au	85	2200	121	118	2363	1933	Bajc and Hall, 2000
Ontario	Sudbury South Range	Ni–Cu–PGE–Au	294	1380	53	NA	433	569	Hashmi *et al.*, 2022
Saskatchewan	La Ronge	Au, Cu	174	1300	NA	NA	NA	43	Dunn, 1998

Note: NA = not analyzed

have been previously reported to contain elevated Au contents (>5 ppb) (McCuaig *et al.*, 2006; Conliffe, 2021), and 2) the study areas have variable levels of infrastructure development and consequently, variable levels of surface disturbance or potential contamination. Potential contamination ranges from well-developed infrastructure and poorly developed, highly disturbed soil profiles in the Nippers Harbour map area to undeveloped areas on Glover Island with well-developed, undisturbed humus. This variability in the level of surface disturbance and humus development may help distinguish between geogenic and anthropogenic geochemical signature in humus across the three sites.

LOCATION AND PHYSIOGRAPHY

The Jackson's Arm area (Figure 1A) is situated in the northwest part of the island of Newfoundland, in the eastern foothills of the Long Range Mountains, west of White Bay as well as the westernmost part of the Baie Verte Peninsula. Sampling focused along the western part of the Jackson's Arm map area, where Jackson's Arm is one of the larger communities. This area is easily accessible by regional Highway 420 and several local service roads. The lowlands are poorly drained and characterized by flat to undulating topography and have numerous wetlands. The highlands reach elevations of approximately 245 m above sea level (asl). Several streams (*e.g.*, Doucer's Brook) and rivers (*e.g.*, Main River), provide regional drainage into White Bay. The Jackson's Arm map area straddles portions of the eastern Long Range region of the Northern Peninsula Forest ecoregion and the north-central region of the central Newfoundland Forest ecoregion. Forests generally comprise balsam fir, black spruce, and eastern larch.

The Nippers Harbour area is 36 km to the east of the Jackson's Arm area and is situated along the northern and eastern coast of the Baie Verte Peninsula and easily accessible

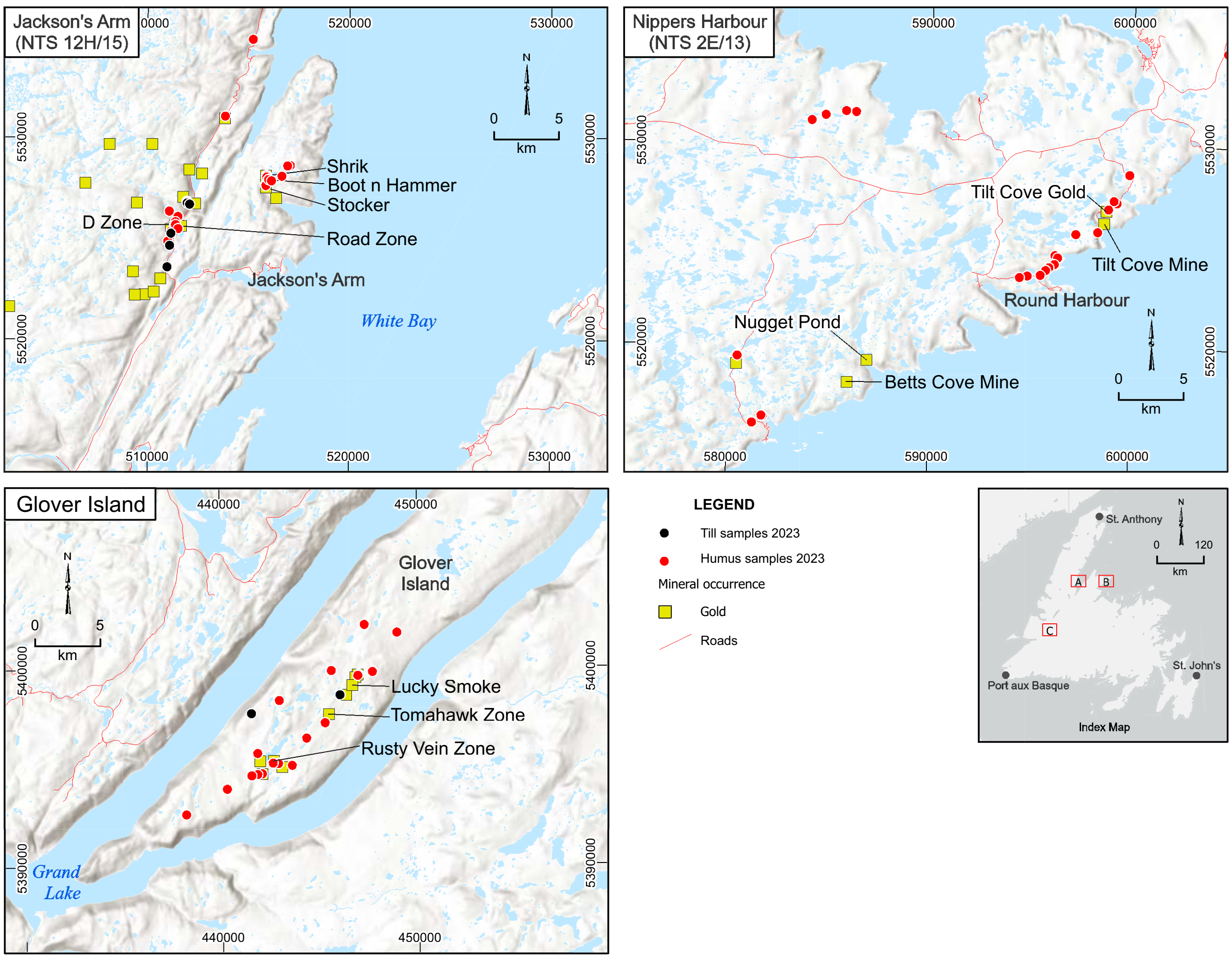


Figure 1. *Location map showing humus and till sampling sites in three areas of the island of Newfoundland: A) Jackson's Arm, B) Nippers Harbour and C) Glover Island.*

by regional highways 414, 415 and 416 and several gravel roads (Figure 1B). La Scie, Snook's Arm, Shoe Cove, Brent's Cove, and Harbour Round are the main communities in the Nippers Harbour map area. The topography varies from undulating uplands and plateaus inland to steeply sloping, hilly, rugged coastal shoreline. There are numerous lakes (*e.g.*, Red Cliff Pond and Loon Pond) and wetlands throughout the region. The Nippers Harbour map area is within the North Shore Forest ecoregion, dominated by black and white spruce inland and shrubs, moss or barren ground near the coast due to increased wind exposure at the coast.

The Glover Island area is located southwest of the other two study areas (Figure 1C), approximately 20 km southeast of Corner Brook. The southern part of Glover Island (where all of the sampling was undertaken) lies within the Little Grand Lake area (NTS 12A/12). Glover Island is a protected Public Reserve that is uninhabited except for seasonal outfitters and research and mineral exploration personnel. The physiography is characterized by steeply sloping cliffs along the northeastern shoreline and undulating to flat topography inland with lakes and abundant wetlands; the highest peak on Glover Island is 595 m asl (McCuaig, 2003). Glover Island is within the Long Range Barrens and the Buchans Plateau–Topsail area ecoregion. Vegetation in this region is dominated by dwarf shrubs (moss heather, sheep laurel heath, and dwarf bilberry), black spruce and balsam fir.

REGIONAL GEOLOGICAL SETTING

BEDROCK GEOLOGY

The bedrock geology of the three study areas (Figure 2A–C) are summarized from Colman-Sadd *et al.* (1990), Cawood *et al.* (1996), McCuaig (2003), McCuaig *et al.* (2006), Kerr (2006), van Staal (2007), Sangster *et al.* (2008), Minnett *et al.* (2010), Skulski *et al.* (2009, 2010), Pilote *et al.* (2014) and Conliffe (2021, 2022).

Jackson's Arm Map Area (12H/15)

The Jackson's Arm map area is dominated by rocks of the Humber (tectonostratigraphic) Zone of the Appalachian Orogen and represents the ancient margin of Laurentia (Williams, 1979; McCuaig, 2003). The oldest rocks are middle Proterozoic basement rocks of the Long Range Inlier and consist of granitic to granodioritic gneisses of the Long Range Gneissic Complex as well as granites of the Lake Michel Intrusive Suite. The Apsy Granite (part of the Lake Michel Intrusive Suite) hosts Au mineralization (*see* Mineral Occurrences: Jackson's Arm). The easternmost part of the study area (*i.e.*, the west coast of the Baie Verte Peninsula) is dominated by highly metamorphosed rocks of the Neoproterozoic to Silurian Fleur de Lys Supergroup, comprising schist, amphibolite and marble. Immediately east of the Long Range Inlier basement rocks, the Doucer's Valley fault complex is a major, northeast–southwest trending fault system that separates the older Long Range Inlier from the younger, Cambrian to Ordovician, platform sedimentary rocks. These platformal rocks consist of autochthonous, clastic and carbonate rocks, including siltstone, sandstone and dolostone and are the remnants of the westward-obducting Iapetus Ocean, during the Taconic Orogeny. Farther east and lying unconformably over the platform sedimentary rocks is the south White Bay allochthon that comprises marine siliciclastic, metavolcanic and felsic to mafic intrusive rocks of the Coney Head Complex (Kerr and Knight, 2004). Lastly, the youngest rocks are the volcanic and sedimentary rocks of the Silurian Sop's Arm Group, which lie unconformably over the Coney Head Group. These include rhyolite, tuff, sandstone, limestone and dolostone (Minnett *et al.*, 2010).

Nippers Harbour Map Area (2E/13)

The Nippers Harbour map area consists of rocks from both the Humber Zone to the west and the Dunnage Zone to the east that are fault bounded between the Green Bay Fault to the east and the Baie Verte–Brompton Line to the west. Of these, the Precambrian to Paleozoic, Ming's Bight Group mapped to the north are the oldest and the only rocks associated with the Humber Zone in the Nippers Harbour map area (*see* Colman-Sadd, 1990). Cambrian to Early Ordovician, mafic to ultramafic, ophiolitic rocks (including boninite) of the Betts Cove Complex and Pacquet Harbour are the oldest rocks of the Dunnage Zone (within the Notre Dame Subzone) and are mapped in the northeast and central parts of the Nippers Harbour map area. These ophiolitic units are collectively termed the "Baie Verte oceanic tract" (BVOT; *see* van Staal, 2007; Pilote *et al.*, 2014). The BVOT ophiolitic rocks are intruded by younger granitoids such as the Silurian Cape Brule porphyry in the north-central map area, Burlington granodiorite to the southeast and the Dunamagon granite to the northwest (Pilote *et al.*, 2014). Early Ordovician Betts Cove Complex is mapped in the northeastern Nippers Harbour map area and consists of a lower ultramafic unit overlain by layered gabbro and massive gabbro that transitions into sheeted dykes and pillowed boninites of the Betts Head Formation. The Betts Head Formation boninites are further subdivided into boninites having low and intermediate TiO_2 contents. The uppermost unit, within the Betts Cove Complex, is the Mount Misery Formation (Skulski *et al.*, 2009), which comprises mafic to ultramafic derived breccia and conglomerate, pillow breccias as well as pillowed basalts that are chemically transitional with and are interbedded with intermediate TiO_2 boninites. The pillow breccias of the Mount Misery Formation host Cu–Au-rich volcanogenic massive sulphide (VMS) deposits, such as those mined at the former Tilt Cove Mine (*see* Mineral Oc-

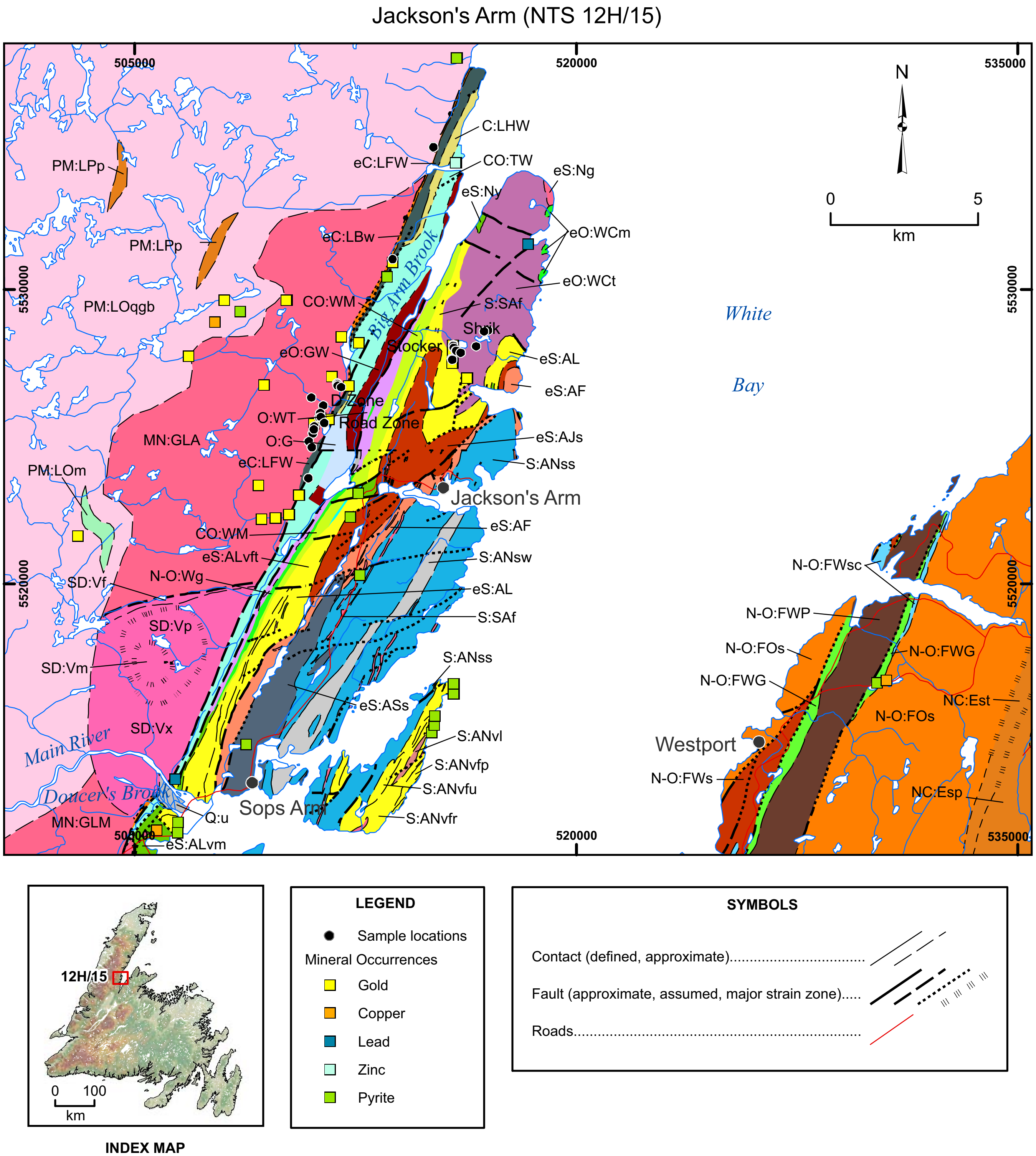


Figure 2. *Bedrock geology and select mineral occurrences in the study areas. Bedrock geology and legends modified after Colman* et al.*, 1990). Coordinates reported in UTM zone 21, NAD27 datum.*

LEGEND (Jackson's Arm)

POST-ORDOVICIAN UNITS
Pleistocene
Surficial deposits

Q:u — Unconsolidated sediments

Early to Late Silurian
Sops Arm Group

Natlins Cove Formation

S:AN — Mixed sequence of shallow marine sandstones and subaerial felsic volcanic rocks

Simms Ridge Formation

eS:AS — Slate and argillite; minor limestone and calcareous tuff

Frenchmans Cove formation

eS:AF — Bedded, polymictic conglomerate and sandstone

Jacksons Arm Formation

eS:AJ — Massive, polymictic boulder to cobble conglomerate; minor mafic volcanic

Lower volcanic formation

eS:AL — Ash-flow tuffs and rhyolite flows, mafic flows, conglomerate, sandstone, dolostone and limestone

S:A — Felsic ash-flow tuffs and rhyolite flows; siltstone and sandstone, limestone,and conglomerate

POST-ORDOVICIAN UNITS (Intrusive Rocks)
Early Silurian to Early Devonian
Devils Room granite

SD:V — Megacrystic to medium-grained, biotite and biotite–muscovite granite; mylonitic granite and

Early to Late Silurian
Intrusions into Sops Arm Group

S:SA — Quartz monzonite sills and felsite dykes and sills

Early Silurian
Intrusions into Coney Head Complex

eS:N — Biotite microgranite, muscovite granite sheets, and mafic to intermediate dykes

LAURENTIAN MARGIN
Humber Zone (Shelf and Related rocks)
Early to Middle Ordovician
St. George Group

Watts Bight Formation

eO:GW — Thick-bedded, grainy, bioturbated and argillaceous limestone

O:G — Bioturbated, thinly bedded and laminated, clean and dolomitic limestone

Middle Cambrian to Early Ordovician
Port au Port Group

CO:TW — Thick-bedded, white dolostone, dolomitic slate, and interbedded dark grey limestone

Neoproterozoic to Early Ordovician
Southern White Bay Allochthon
Taylors Pond Formation

O:WT — Black graphitic slate with calc-silicate beds

Neoproterozoic to Middle Cambrian
Labrador Group

Hawke Bay Formation

C:LHW — Quartz sandstone, sandy dolomite, oolitic *limestone, and calcareous slate*

Forteau Formation

eC:LFW — Graphitic slate and phyllite, calcareous schist and marble

Bradore Formation

eC:LB — Crossbedded, arkosic, sandstone, pebbly sandstone and siltstone

Late Mesoproterozoic to Neoproterozoic
Grenvillian granitoid rocks
Leucocratic granitoids

Main River pluton

MN:GLM — Pink, massive to foliated, potassium feldspar megacrystic biotite ± hornblende granite

Aspy pluton

MN:GLA — Potassium feldspar-megacrystic biotite ± hornblende granite

Late Paleoproterozoic to Early Mesoproterozoic
Long Range gneiss complex
Orthogneiss (may include some paragneiss)

PM:LO — Quartz dioritic, granitic–granodioritic, and mafic gneisses

Paragneiss

PM:LP — Gneiss, quarzite and quartz-rich gneiss, and marble and calc-silicate rock

LAURENTIAN MARGIN
Humber Zone (Slope and Related rocks)
Middle to Late Ordovician
Granby Island Formation

O:GY — Dark grey to black slate, argillite, and greywacke; minor boulder conglomerate

Neoproterozoic to Early Ordovician
Fleur de Lys Supergroup
Old House Cove group

N-O:FOs — Buff to grey weathering, medium- to coarse-grained, and semipelitic schist

N-O:FO — Medium- to coarse-grained schist

White Bay Group

Pigeon Island formation

N-O:FWP — Mainly garnet-porphyroblastic, quartz-muscovite schist, locally magnetite rich

Garden Cove formation

N-O:FWG — Green amphibolite and mafic schist

N-O:FW — Pelitic, and graphitic schist, amphibolite, mafic schist, marble and carbonate schist

Southern White Bay Allochthon
Taylors Pond Formation

O:WTM — Melange containing green sandstone, quartzite, serpentinite and talc blocks

N-O:W — Tonalite and gabbro, slate, sandstone, and greenschist

Early Mesoproterozoic to Early Cambrian
East Pond Metamorphic Suite

Middle Arm metaconglomerate

NC:EM — Mainly polymict metaconglomerate with interlayered psammitic schist

M-C:E — Psammitic and semipelitic schist and gneiss; migmatite, quartzofeldspathic gneiss

IAPETUS OCEAN
Dunnage Zone (Notre Dame Subzone)
Neoproterozoic to Early Ordovician
Southern White Bay Allochthon
Coney Head Complex

eO:WC — Biotite tonalite, gabbro and quartz gabbro

Figure 2. *Continued*

Nippers Harbour (NTS 2E/13)

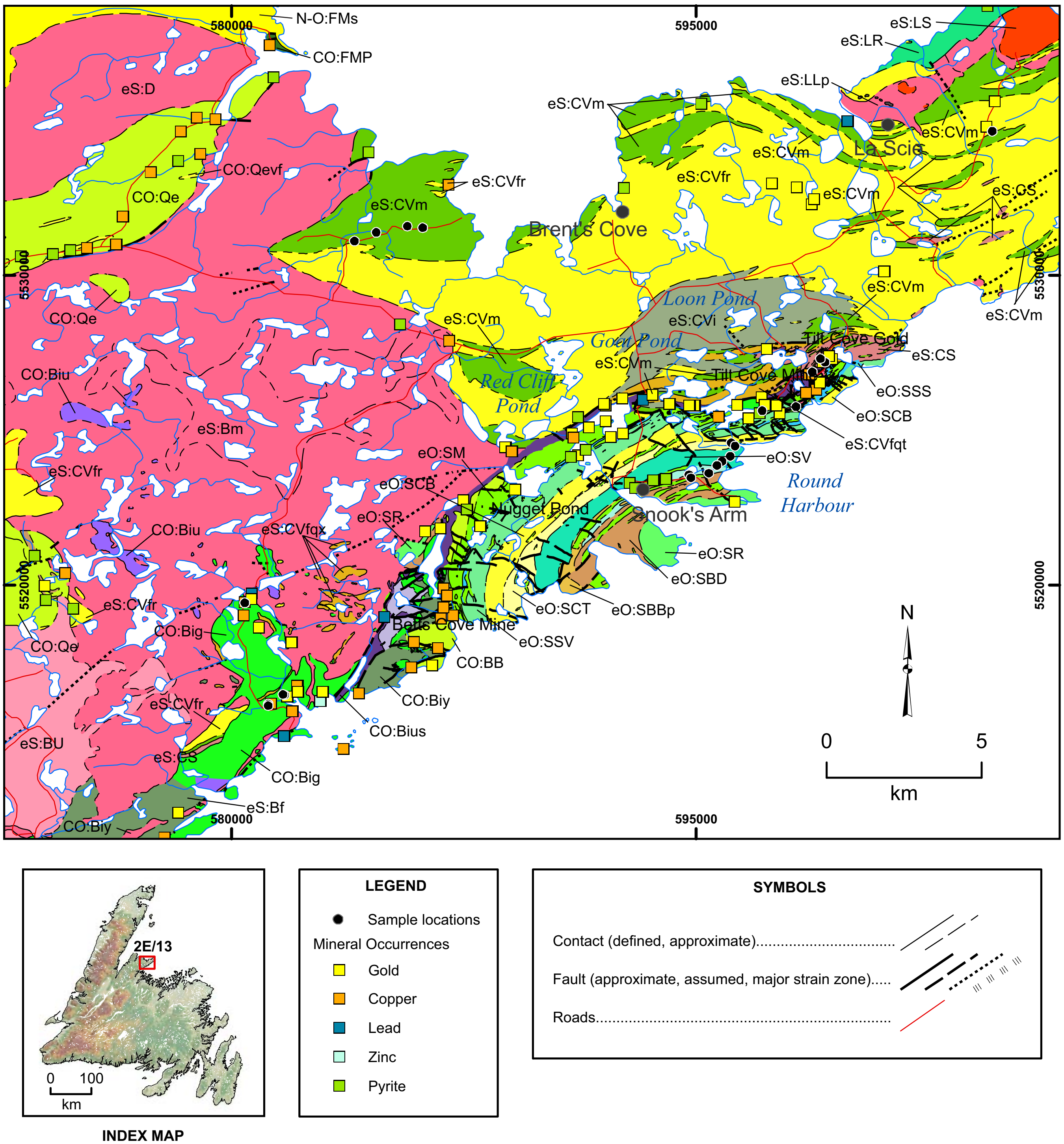


Figure 2. *Continued*

LEGEND (Nippers Harbour)

POST-ORDOVICIAN UNITS (Overlap Sequences)

Early Silurian

King's Point Complex

Volcanic rocks

eS:KV	Aphyric to porphyritic ash-flow tuffs, lapilli-tuffs, breccias, and intrusive equivalents

Cape St. John Group

Volcanic rocks

eS:CV	Bimodal sequence of rhyolitic and ash flow tuffs, flows and andesitic to dacitic flows

Sedimentary rocks

eS:CS	Crossbedded sandstone and conglomerate, including minor mafic lava and felsic tuff

POST-ORDOVICIAN UNITS (Intrusive Rocks)

Early Silurian

La Scie intrusive suite

La Scie granite

eS:LL	Fine- to medium-grained, pink, biotite granite; locally feldspar porphyritic

Seal island Bight syenite

eS:LS	Grey-weathering, fine- to medium-grained syenite

Reddits Cove gabbro

eS:LR	Dark grey-green, fine- to medium-grained, equigranular pyroxene gabbro
eS:L	Biotite granite, riebeckite syenite, and pyroxene gabbro

Cape Brule Porphyry

eS:B	Quartz-feldspar porphyry containing mafic and ultramafic xenoliths

Dunamagon granite

eS:D	Medium- to coarse-grained, pink, biotite granite

Burlington granodiorite

eS:BU	Mainly light grey to greenish grey, medium-grained, hornblende–biotite granodiorite and quartz diorite

LAURENTIAN MARGIN

Humber Zone (Slope and related rocks)

Neoproterozoic to Early Ordovician

Fleur de Lys Supergroup

Ming's Bight Group

N-O:FM	Buff to grey weathering, psammitic and semipelitic schist with minor quartz pebble metaconglomerate

IAPETUS OCEAN

Dunnage Zone (Notre Dame Subzone)

Early Ordovician

Snooks Arm Group

Round Harbour Formation

eO:SR	Clinopyroxene + plagioclase–phyric pillow lavas and sheet flows; thin red siliceous mudstone interbeds

Balsam Bud Cove Formation

eO:SB	Basal member of pelagites and volcaniclastic turbidites interbedded with mafic volcanic rocks

Venams Bight Formation

eO:SV	Pillow lavas and sheet flows

Bobby Cove Formation

eO:SC	Basal member of andesite tuffs characteristic thick-bedded, crudely stratified, graded, block and lapilli tuffs

Scrape Point Formation

eO:SS	Basal sedimentary member of breccia or conglomerate overlain turbiditic sandstones and siltstones

Mount Misery Formation

eO:SM	Olivine-phyric tholeiitic pillow lavas and pillow breccias; uppermost lavas commonly hematized and/or strongly magnetic
eO:S	Arc tholeiitic pillow lava, pillow and talus breccia and associated mafic dykes; evolved tholeiitic pillow basalt and massive flows

Late Cambrian to Early Ordovician

Pacquet Harbour group

CO:Q	Pillow lava, pillow breccia, and other mafic volcanic rocks and diabase dykes

Betts Cove Complex

Betts Head Formation

CO:BBx	Brecciated facies
CO:BB	Olivine + chromite + orthopyroxene–phyric boninitic pillow lavas
CO:Biy	Sheeted dyke complex
CO:Bigbx	Brecciated gabbro–gabbronorite and related intrusive rocks
CO:Bigb	Massive gabbro–gabbronorite, subordinate hornblende diorite and trondjemite
CO:Big	Gabbro with pods and layers of pyroxenite cut by diabase dykes
CO:Biuc	Layered cumulates comprising cumulate peridotites, pyroxenites (orthopyroxenite, clinopyroxenite, and gabbronorite
CO:Bius	Schists derived from altered and deformed peridotites
CO:Biu	Interlayered dunite, peridotite and pyroxenite, and serpentinized ultramafic and talc–carbonate rock

Neoproterozoic to Early Ordovician

Fleur de Lys Supergroup

Ming's Bight Group

Pelee Point schist

CO:FMP	Dark green amphibolite and greenschist; minor raphitic and pelitic schist

Figure 2. *Continued*

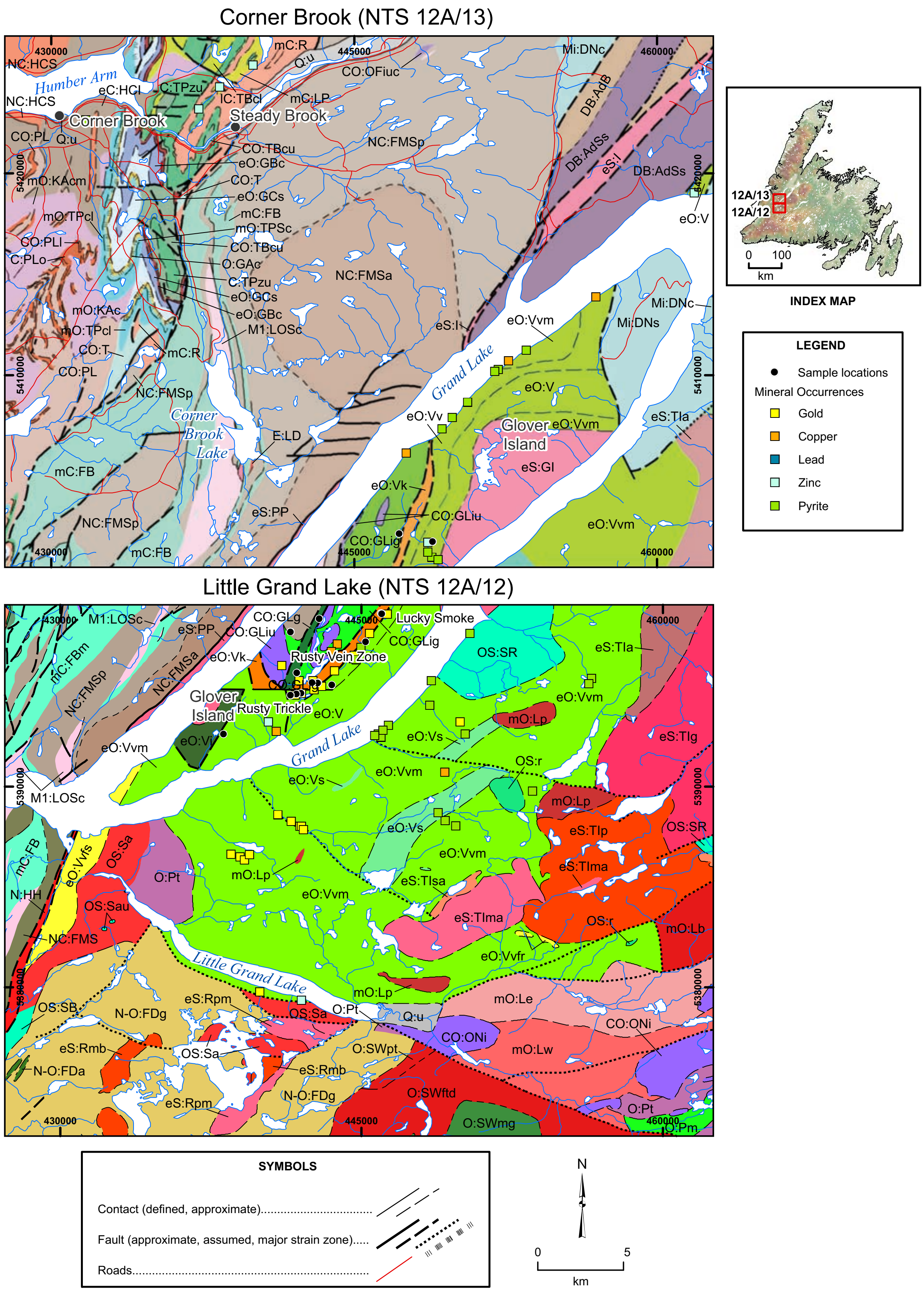


Figure 2. *Continued*

LEGEND (Corner Brook and Little Grand Lake)

POST-ORDOVICIAN UNITS
(Overlap Sequences)
Pleistocene
Surficial deposits

- Q:u — Unconsolidated sediments

Mississippian
Deer Lake Group

Rocky Brook Formation

- Mi:DR — Siltstone, sandstone, mudstone, and dolomitic oil shale

North Brook Formation

- Mi:DN — Pebble to boulder conglomerate and calcareous sandstone

Late Devonian to Mississippian
Anguille Group (Deer Lake Basin)

Saltwater Cove Formation

- DB:AdS — Sandstone and siltstone, limestone and dolostone

Blue Gulch Brook Formation

- DB:AdB — Quartz pebble conglomerate, sandstone and siltstone

POST-ORDOVICIAN UNITS
(Intrusive Rocks)
Early Silurian
Star Lake intrusive suite

- eS:R — Foliated granite and minor granodiorite intrusions

Topsails Igneous Suite

Intrusive rocks

- eS:TI — Granite, granodiorite, syenite and gabbro,
- eS:pg — Pegmatite and granite

Island Pond pluton (Grand Lake)

- eS:I — Foliated granite and pegmatite

Little Paddle Point pluton

- eS:PP — Granodiorite with minor granite, gabbro and diorite

Glover Island Granodiorite

- eS:GI — Foliated, equigranular, granodiorite

Late Ordovician to Early Silurian
Southern Long Range mafic intrusions
Main Gut intrusion

- eS:SM — Tholeiitic gabbro, diorite, diabase and layered norite

Rainy Lake Complex

- OS:SR — Gabbro, diorite and quartz diorite, and granodiorite

Bottom Brook intrusion

- OS:SB — Gabbro, norite, and diorite
- OS:S — Gabbro, lecogabbro, diorite, quartz diorite, and granodiorite
- OS:r — Gabbro intrusive into Ordovician rocks

LAURENTIAN MARGIN
Humber Zone (Shelf and Related Rocks)
Middle to Late Ordovician
Goose Tickle Group

American Tickle Formation

- mO:KA — Shales and sandstones, locally metamorphosed

Middle Ordovician
Table Head Group

Table Cove Formation

- mO:TC — Bioturbated and fossiliferous, limestone overlain by shale

Table Point Formation

- mO:TP — Argillaceous and dolomitic limestone; locally grainstone
- mO:T — Argillaceous and dolomitic limestone; locally grainstone

Early to Middle Ordovician
St. George Group

Aguathuna Formation

- O:GA — Limestone, dolostone or dolostone with or without shales

Catoche Formation

- eO:GC — Dolomitic and limestone with skeletal-intraclastic grainstone and rudstone

Boat Harbour Formation

- eO:GB — Interbedded limestone and dolostone; chert locally

Watts Bight Formation

- eO:GW — Argillaceous and dolomitic limestone interbedded with dololaminites

Ediacaran
Lady Slipper Pluton

- E:LD — Tonalitic to granodioritic gneiss

Neoproterozoic to Middle Cambrian
Labrador Group

Penguin Cove Formation

- mC:LP — Shale, phyllite and slate commonly cut by sandstone dykes
- NC:L — Arkosic conglomerate; arkosic, micaceous, hematitic and calcareous sandstones

Neoproterozoic
Hare Hill Granite

- N:HH — Foliated to lineated leucogranite; intensely sheared muscovite granite

Late Paleoproterozoic to Early Mesoproterozoic
Long Range gneiss complex

Orthogneiss (may include some paragneiss)

Southern Long Range

- M1:LOS — Granitoid gneiss; psammitic gneiss; hornblende–plagioclase gneiss

LAURENTIAN MARGIN
Humber Zone (Slope and Related Rocks)
Middle Cambrian to Middle Ordovician
Pinchgut Lake Group

- CO:PL — Slate, and calcareous and dolomitic phyllite, dolomitic and phyllitic

Neoproterozoic to Middle Ordovician
Humber Arm Allochthon (low structural slices)
Curling Group

Irishtown Formation

- eC:HCI — Pyritic slate; graded andstone, and polymictic conglomerate

Summerside Formation

- NC:HCS — Slate interbedded with arkosic sandstone

Neoproterozoic to Early Ordovician
Fleur de Lys Supergroup
Breeches Pond Formation

- mC:FB — Graphitic schist, mica, marble and meta-limestone conglomerate

Mount Musgrave Group

South Brook Formation

- NC:FMS — Schist, quartzite, marble, amphibolite and quartz pebble conglomerate

Dashwoods Subzone

- N-O:FD — Metasedimentary gneisses and schists of the Dashwoods Subzone

Figure 2. *Continued*

currences: Nippers Harbour). Volcanic rocks of the Snooks Arm Group are the cover sequence to the Betts Cove Complex. Of these, the Scrape Point Formation, which is stratigraphically the lowest unit of the Snooks Arm Group, is mapped in the northeastern corner of the Nippers Harbour map area. The lowest unit of the Scrape Point Formation is the Nugget Pond Horizon that consists of local basal conglomerate (breccia of basalt clasts cemented by jasper), red siltstone and jasper–magnetite iron formation. Rocks of the Nugget Pond Horizon underwent epigenetic albite–carbonate–quartz–pyrite-alteration and host the Nugget Pond Au deposit (*see* Mineral Occurrences: Nippers Harbour). In the northwestern map area, metamorphosed volcanic and sedimentary rocks of the Early Ordovician Pacquet Harbour Group, are correlative to the Snooks Arm Group based on petrological and geochemical similarities (Skulski *et al.*, 2010). Volcanic and sedimentary units of the Pacquet Harbour Group consist of felsic tuff and rhyolitic flows, gabbroic dykes, pillow basalts as well as black chert and magnetite Fe formations. Lastly, the youngest rocks are Late Ordovician to Early Silurian, volcanic and volcaniclastic rocks of the Cape St. John Group mapped in the northeastern Nippers Harbour map area. The Cape St. John Group includes a basal conglomerate, redbed arkose and siltstone, welded tuff and heterolithic crystal tuff containing ultramafic fragments as well as a pyroclastic breccia and conglomerate comprising basalt, pumice and rhyolite fragments.

Glover Island (Corner Brook 12A/13 and Little Grand Lake 12A/12 Map Areas)

Glover Island lies at the boundary between the Humber and Dunnage (tectonic) zones of the Newfoundland Appalachians (Williams, 1979). The Humber Zone rocks mapped in the west part of the Island consist of highly deformed, undifferentiated rocks of the Corner Brook Lake Block, an allochthonous terrane interpreted to have been transported over 400 km (Knapp, 1982; Cawood *et al.*, 1996; Conliffe, 2021). The Dunnage Zone rocks dominate the rest of Glover Island and consist of Cambrian to Early Ordovician, metasedimentary to metavolcanic rocks of the Grand Lake Complex, Early Ordovician, sedimentary to volcanic rocks of the Glover Group, and Early Ordovician to Silurian, intrusive complexes. Of these, the oldest rocks, *i.e.*, ophiolitic rocks of the Grand Lake Complex, are inferred to represent the southern extension of the BVOT (van Staal *et al.*, 2007). The Grand Lake Complex is characterized by altered ultramafic rocks, including schist, serpentinized peridotite and wehrlite overlain by relatively unaltered gabbro, trondhjemite, tonalite, sheeted dykes, pillow lavas and basalt (Knapp, 1982; Cawood *et al.*, 1996).

The Grand Lake Complex is in fault contact with the Early Ordovician Glover Group, a sequence of sedimentary and volcanic rocks inferred as the cover sequence to the ophiolites (after Barbour *et al.*, 2012; Conliffe, 2021). Of these, the lowest stratigraphic unit is the Kettle Pond Formation, host to Au mineralization on Glover Island (Conliffe, 2021). The base of the Kettle Pond Formation is defined by a lower Basal Conglomerate Member that is overlain by felsic to volcanic rocks (Szybinski *et al.*, 2006). The Basal Conglomerate Member is characterized by strongly deformed, clast supported, polymictic, pebble to cobble conglomerate. The Kettle Pond Formation overlying the Basal Conglomerate Member consists of interlayered, fine-grained felsic and mafic tuffs interspersed with thicker mafic volcanic rock units (Szybinski *et al.*, 2006; Barbour *et al.*, 2012). Overlying the Kettle Pond Formation are the volcanic rocks of the Tuckamore Formation, a thick sequence of pillow basalt and plagioclase–porphyritic flows having minor shale and massive sulphides (Knapp, 1982; Szybinski *et al.*, 2006). The Corner Brook Pond Formation is the youngest end member of the Glover Group and it unconformably overlies the Tuckamore Formation. The Corner Brook Pond Formation is characterized by sedimentary and volcanic rocks, including felsic epiclastic units with minor rhyolite, pillow basalt, shale, chert and carbonate rocks. The rocks of both the Grand Lake Complex and the Glover Group have undergone greenschist-facies metamorphism (Szybinski *et al.*, 2006; Conliffe, 2022). The Glover Group is intruded by the Silurian Glover Island Granodiorite on the northeastern side of Glover Island, and the youngest rocks on Glover Island are Carboniferous sedimentary rocks of the Deer Lake Basin that lie unconformably over the Glover Group (Cawood *et al.*, 1996).

MINERALIZATION

Jackson's Arm Map Area

There are several Au occurrences in the Jackson's Arm map area associated with the Doucer's Valley Fault System (GSNL, 2023a). These include the Rattling Brook deposit associated with Silurian to Devonian plutonic rocks, and Boot n Hammer, Stocker, and Shrik Au showings associated with Precambrian plutonic rocks.

The region near the Rattling Brook deposit was first explored by Labrador Mining and Exploration Limited in 1982 following informal reports of Au found in drillcore during the Cat Arm hydroelectric project (1977 and 1978; Harrington and Cullen, 2022). Subsequent exploration by Labrador Mining and Exploration Limited reported Au ranging 1 to 2 g/t in pyrite-bearing granite along the Cat Arm access road (Harrington and Cullen, 2022). Copper–Au–Ag mineralization is hosted in disseminated- and veinlet-style arsenopyrite and pyrite. Mineralization occurs in intensely deformed, highly sheared and fractured zones with prevalent silicic and potassic alteration (Tuach, 1986), within Apsy Granite and the quartzites and limestones of the Forteau Formation at the Beaver Dam and Apsy zones (Kerr, Breemen and Creaser, 2006). The main ore minerals are chalcopyrite, arsenopyrite and pyrite (*see* Regional Bedrock Geology: Jackson's Arm). Other alteration minerals include Fe carbonate, hematite and sericite. Up to 1.5 and 1.13 g/t Au have been reported in grab samples from the Apsy Zone and the Road Zone, respectively (Bruneau, 1984). Resource estimates (as of 2019) report an inferred resource of approximately 5.5 million tonnes of ore grading at 1.45 g/t Au (Harrington and Cullen, 2022).

The Boot n Hammer, Stocker and Shrik showings lie within altered granodiorites of the Cambro-Ordovician Coney Head Complex of the south White Bay Allochthon. The Stocker and Shrik showings are approximately 100 m north and 400 m south of Boot n Hammer, respectively. At all three showings, Au is associated with disseminated pyrite (2–10%) within quartz veins and altered granodiorite. Up to 20.2 g/t Au and 1232 g/t Ag has been recovered by assay from a grab sample at the Boot n Hammer showing (GSNL, 2023a).

Nippers Harbour Map Area

The Early Ordovician ophiolitic rocks of the BVOT host Au and base-metal mineralization in the Baie Verte Peninsula. These ophiolitic rocks host VMS-style Cu and Au in felsic and mafic volcanic sequences as well as Au in hydrothermally altered mafic and ultramafic rocks. The volcanic cover sequence to the Betts Cove Complex (*i.e.*, the Snooks Arm Group) also hosts epigenetic Au associated with banded iron formation as well as in association with deformed mafic rocks (Skulski *et al.*, 2009, 2010). Of these, the deposits at past producing Tilt Cove and Nugget Pond Au mines, and Betts Cove platinum group element (PGE) occurrence are notable and will be discussed further. The Tilt Cove deposit (which hosts the Tilt Cove Mine) was discovered in 1857 and mining began in 1864 (Signal Gold Inc., 2022). The Tilt Cove Mine is host to significant base- and precious-metal mineralization (Cu–Au–Ni–Ag–Zn) and is characterized as a VMS deposit. Between 1864 and 1967, 8 160 000 tonnes of ore, grading up to 12% Cu, and approximately 42 000 ounces of gold were mined at the Tilt Cove Mine (Signal Gold Inc., 2022). The host rocks are highly deformed (sheared, brecciated and chloritized), felsic extrusive, basaltic to andesitic pillow lavas and pillow breccia of the Mount Misery Formation of the Snooks Arm Group (also referred to as the Betts Cove Ophiolite Complex, (*see* MODS; Geological Survey of Newfoundland and Labrador, 2023a). Mineralization is hosted in massive sulphides dominated by pyrite and chalcopyrite, and to a lesser extent sphalerite, pentlandite, nickeline, maucherite, gersdorffite and millerite that form stockwork, clusters, stringers and fine-grained disseminated veins. Gold and Ag are present as alloys; native Ag has also been noted (Skulski *et al.*, 2009). The Betts Cove deposit hosts the past producing Betts Cove Mine and contains Cu–Zn–Au mineralization. The Betts Cove deposit was discovered in the early 1860s and from 1875 to 1886 approximately 130 000 tonnes of ore grading 10% copper and 2450 tons of pyrite were mined (Signal Gold Inc., 2022). Copper–Zn–Au mineralization is hosted in massive to disseminated pyrite and chalcopyrite; Au mineralization is hosted along the (sheared) contacts between pillow basalt and gabbroic sills. The primary ore minerals are chalcopyrite, pentlandite and native Au, as well as secondary pyrite and pyrrhotite and ore samples have returned up to 10 g/t Au, 18.3% Cu and 2% Zn contents (Signal Gold Inc., 2022). The Nugget Pond Au deposit is host to the past producing Nugget Pond Mine. The deposit is hosted within the sedimentary, volcanic and volcaniclastic rocks of the Nugget Pond horizon of the Snooks Arm Group. Gold is associated with extensive quartz–albite–carbonate–pyrite alteration. Gold (and lesser Cu and Pb) are primarily hosted in chalcopyrite, pyrrhotite, pyrite and galena (to a lesser extent), although native Au is present locally and Ag occurs as Ag-tellurides. The former Nugget Pond Mine contained approximately 448 000 tonne of ore, grading approximately 12.3 g/t Au (Sangster *et al.*, 2008).

Other notable Au and Cu occurrences include the following:

1) The Muirs Pond Cu prospect is a structurally controlled, mesothermal vein system that also hosts Ag and Au (GSNL, 2023a). Up to 0.2% Cu, 0.3% Ni and 0.5% Zn were reported from assayed sampled (Advocate Mines Ltd., 1967). Mineralization occurs in small blebs and consists of veinlets and disseminated chalcopyrite, pyrrhotite and arsenopyrite. The alteration in the host rocks (gabbro and pyroxenite) is characterized by silicification and chloritization (Advocate Mines Ltd., 1967). The Cape Road 01 Au showing is a weakly pyritized dacitic tuff with limonite. Rock chip samples returned up to 452 ppb Au (Pronovost and Helt, 2013).

2) The Nippers Harbour North Au indication is a structurally controlled and hydrothermally altered vein system that is part of the sheared mafic dykes of the Betts Cove Ophiolite Complex. Grab sample from the Nippers Harbour North Au indication returned up to 4.59 g/t Au and 3260 ppm Cu (Wallace and Wesa, 1988).

Glover Island

All Au mineralization on Glover Island are hosted in the Basal Conglomerate Member and volcanic rocks of the Kettle Pond Formation of the Glover Group (Conliffe, 2021, 2022). These cover rocks are interpreted as the southern extension of the BVOT (van Staal *et al.*, 2007), which is host to numerous economic VMS occurrences such as the past producing Tilt Cove Mine (*see* Mineral Occurrences: Nippers Harbour).

The Basal Conglomerate Member hosts the Lunch Pond Vein and Discovery Vein occurrences (*see* Bedrock Geology for Glover Island; Figure 2). Gold mineralization occurs as massive, quartz veins in strongly altered and deformed metaconglomerate; alteration minerals include carbonates, sericite, fuchsite and chlorite (Conliffe, 2021). Free Au is present in inclusions within pyrite and chalcopyrite, and up to 150 g/t Au over 1.5 m has been reported in a channel sample at Lunch Pond Vein (Conliffe, 2021).

Volcanic-hosted Au mineralization occurs in the strongly deformed felsic and mafic rocks (*e.g.*, felsic and mafic tuff, rhyolite) of the Kettle Pond Formation, such as at the Lunch Pond Vein, Keystone, Lunch Pond Southeast, Lucky Smoke and Rusty Vein Au occurrences. These volcanic rocks have undergone multi-phase alteration, consisting of earlier, regional chlorite–epidote alteration and later silicic and hydrothermal alteration (Conliffe, 2021). At the Keystone showing, silicified, quartz-rich sediment of the Glover Formation with inter-grain Fe-carbonate and/or Fe-oxide with approximately 5% pyrite returned up to 2070 ppb Au (Conliffe, 2021). Channel sampling at the Keystone showing returned 3.74 g/t Au over 4 m and up to 1.65 g/t Au over 4 m in drillcore. Drilling at the Kettle Pond South occurrence returned 4.8 g/t Au over 18.5 m, whereas drilling at the Lucky Smoke occurrence returned 10.18 g/t Au over 8 m. At Lunch Pond South extension developed prospect, drilling returned 1.74 g/t Au over 53.5 m, with an indicated mineral resource estimate of approximately 58 200 oz. gold and inferred mineral resource of 120 600 oz. Au (Puritch and Barry, 2017). Up to 11.3 g/t Au over 2 m was also reported in a channel sample and 1.79 g/t Au over 1.5 m in drillcore at the Rusty Vein occurrence. There are also VMS-style mineral occurrences hosted in the Kettle Pond Formation, in stratabound, structurally controlled, volcanogenic stockworks having mixed felsic and mafic volcanic rock sequences of the Glover Formation.

Strongly altered aphanitic, felsic and mafic tuffs as well as quartz feldspar porphyritic rhyolites host most Au mineralization (Conliffe, 2021). The alteration is characterized by silica, sericite and to a lesser extent, chlorite and Fe-carbonate. Gold, Ag, Cu, Zn and Pb occur within hydrothermally altered, quartz feldspar porphyritic rhyolites as pyrite, chalcopyrite, sphalerite and galena (GSNL, 2023a). The Rusty Trickle showing represents the largest known VMS-style occurrence on Glover Island. Here, the mineralized zone consists of stringer Zn–Cu–Ag mineralization hosted in quartz feldspar–plagioclase rhyolites. Bedrock samples, collected within hydrothermally altered zones (in deformed quartz feldspar porphyritic rhyolites), from the Rusty Trickle Prospect have 0.5–12.9% Zn, 0.2–1.58% Cu, 0.15–1.16% Pb and 5.0–15.6 g/t Ag (Basha *et al.*, 2001; Conliffe, 2022).

QUATERNARY GEOLOGY AND ICE-FLOW PATTERNS

A summary of the regional glacial and deglacial events associated with the late Wisconsinan glaciation on the island of Newfoundland is based on work by Grant (1974, 1986, 1989), Liverman (1992, 1994), Batterson and Liverman (2001), Batterson (2003), McCuaig (2003), McCuaig *et al.* (2006) and Shaw *et al.* (2006). Most of Newfoundland was covered by the Appalachian Ice Complex, comprising a series of independent ice centres that developed in the Long Range Mountains and the Gaff Topsails, as well as on the Avalon Peninsula (Batterson and Liverman, 2001). Radial ice flow from these centres coalesced to produce complex, multi-directional ice flow.

Ice retreat may have commenced between 13–10 ka BP (thousands of years before present); the coastal areas were the first to become ice free at about 14–11 ka BP (Batterson and Liverman, 2001). Ice sheets disintegrated primarily *via* ablation and ice stagnation, shrinking and becoming isolated as multiple, smaller ice caps (Grant, 1974; Shaw *et al.*, 2006). Retreating glaciers became topographically controlled in the Long Range Mountains and the shelf ice caps persisted until 11 000 years BP, when Younger Dryas cooling resulted in a limited glacial re-advance on the island. Deglaciation was mainly complete by 10 ka BP (Shaw *et al.*, 2006).

Three, late Wisconsinan ice-flow phases were identified in the Jackson's Arm map area (McCuaig, 2003; Hashmi, 2021): an earlier east–southeast flow that followed topography into White Bay during glacial advance; north–northeast flow across White Bay during glacial maximum, and an east, southeastward flow into White Bay during glacial retreat.

Two distinct ice-flow directions were identified in the Nippers Harbour map area that were associated with three difference phases of glacial movement in the Baie Verte region (Liverman, 1992). A southeastward flow from the Long Range Mountains west of White Bay during the last glacial maximum (just west of the Jackson's Arm map area). This southeastward flow was followed by a northeastward flow across the Baie Verte peninsula. This was followed by another southeastward flow during the third phase, which was associated with a late-stage ice divide, that formed in the central part of the Baie Verte Peninsula.

On Glover Island, Batterson (2003) recognized a north–northwestward flow that was influenced by radial ice-flow originating from an ice centre in the Topsails (Figure 3). This ice-flow also influenced the glacial dispersal in the region (McCuaig *et al.*, 2006).

METHODS

SAMPLE COLLECTION

During the 2022 field season (June–September), 76 humus and 8 till samples were collected for geochemical analyses *via* truck, ATV or by foot traverse in the 3 study areas. Note that humus and till samples collected on Glover Island required helicopter support. Field data were collected using custom forms created for the ESRI Survey 123 mobile application to digitally record site and sample characteristics. Photographs were taken to document each site and sample.

Humus

At each humus sample site, live surface vegetation and debris were cleared from the soil surface using a shovel and a reciprocating saw to expose the humified layer (Plate 1). Humus samples weighing approximately 750 g were typically collected in a plastic bag using a stainless-steel knife at approximately 3 cm depth; deeper (at 5 cm) samples were collected in disturbed areas to avoid airborne dust, mineral or other particulate matter contamination. If present, the presence of charcoal in humus samples was also documented. Humus samples were collected in areas directly overlying and in the vicinity of known Au mineralization, as well as in "background" areas, *i.e.*, outside of known Au mineralization, to compare their geochemical signatures with those collected proximal to mineralization. Humus samples were preferably collected near outcrop to increase confidence in a local source for geochemical signatures. A field duplicate was collected every 5 to 10 samples, depending on the availability of well-developed humus. Field data collection specific to humus samples included humus development (poorly *vs.* well-developed), presence of charcoal, mineral matter, sample depth, vegetation type and location of outcrop.

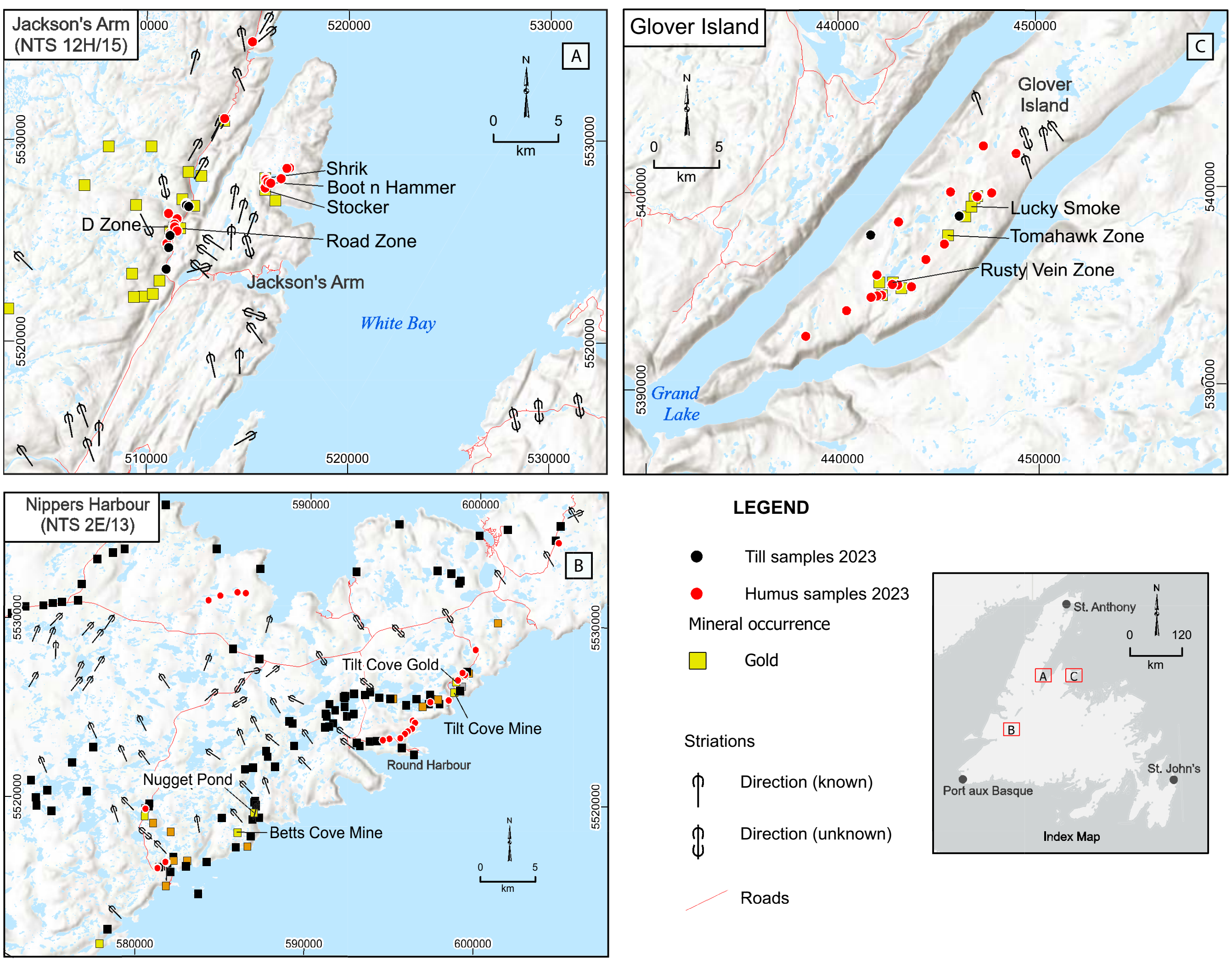


Figure 3. *Ice-flow movement in the three study areas: A) Jackson's Arm, B) Nippers Harbour and C) Glover Island.*

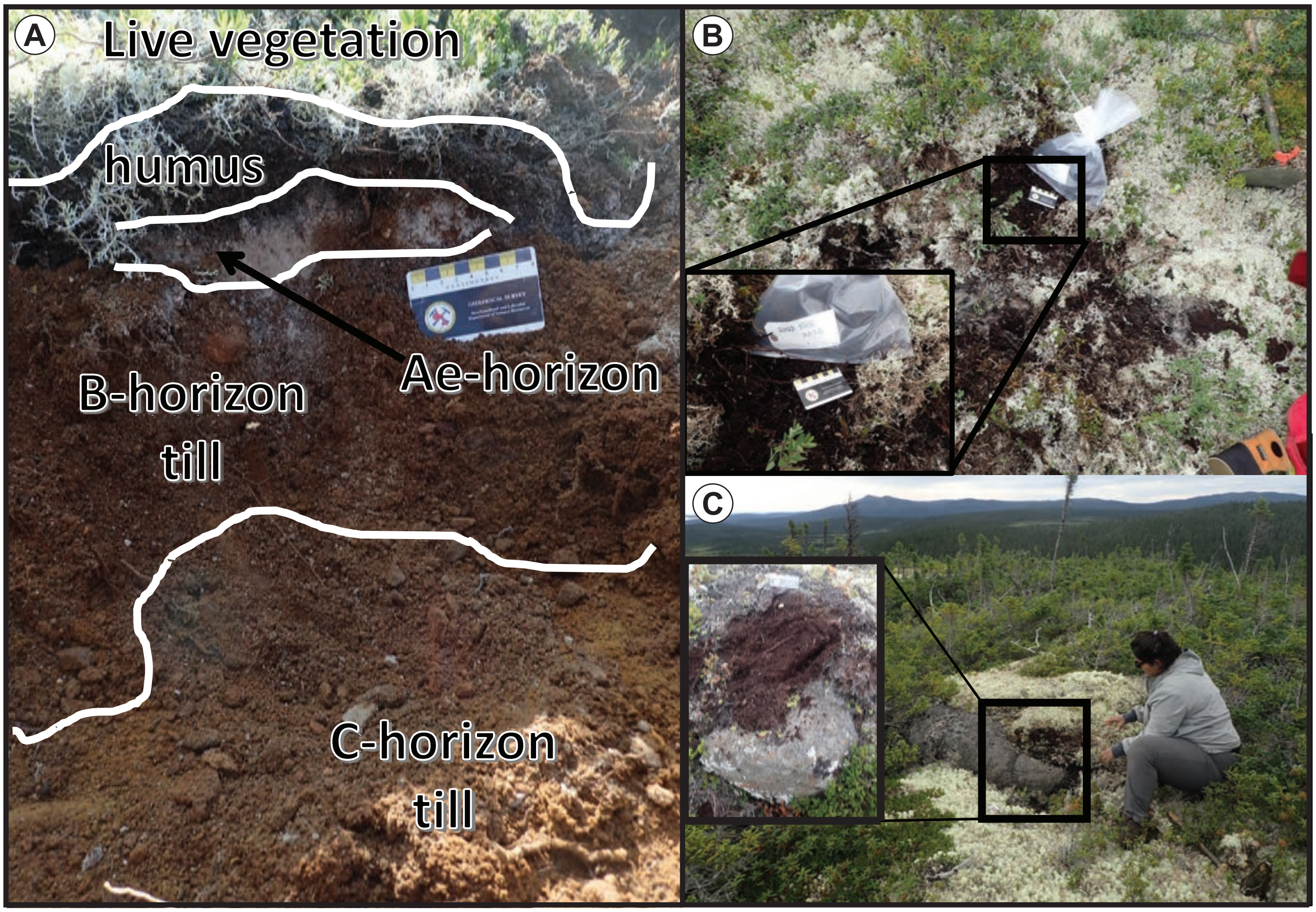


Plate 1. *Example of sampling site for humus.*

Till

Due to paucity of till, only 8 samples were collected during fieldwork in the 3 study areas; 5 samples were collected in the Jackson's Arm map area and 3 were collected on Glover Island. None of the till sampling sites coincided with humus samples sites. Till samples were collected using the Geological Survey of Canada's sampling protocol (McClenaghan *et al.*, 2020). Till samples weighing approximately 2 to 3 kg were collected from a depth ranging from 3–30 cm, where sample depth was dependent on thickness (Plate 2). Till sampling equipment included a mattock, a shovel and a geological pick. At each site, the sediment face was cleaned, or a pit was dug. Till samples were collected in a plastic bag from a depth ranging from a few to tens of cm, from B- or BC-horizon soil horizon.

Information collected at each sample site included location (GPS coordinates), site description and geomorphology, sedimentary structures, soil horizon, till quality and till characteristics (*e.g.*, relative percentages of clasts and matrix, *i.e.*, sand, silt and clay, colour and clast content) and general site observations such as evidence of post-depositional disturbances (*e.g.*, agricultural/mining activity). Both humus and till could not be collected at each site, either due to poor humus development, or a lack of sufficient till.

SAMPLE PREPARATION, PROCESSING AND ANALYTICAL METHODS

Humus

At the Geological Survey of Newfoundland and Labrador (GSNL) geochemistry laboratory in St. John's, each humus sample bag was opened and air-dried (covered with a paper towel) for one week, then spread onto an aluminum pan and fully dried in a Hotpack® oven at 45°C for 48–60 hours (Figure 4). The fully dried humus sample was returned to its original plastic sample bag and gently crushed using a rubber mallet to break up larger pieces of decomposed organic matter. If a sample contained abundant roots, needles, and woody material, it was passed through a 2 mm (10 mesh) stainless

Plate 2. *Example of sampling site for till.*

steel sieve after the initial crushing to remove them. The crushed sample was then sieved through a 180 µm (80 mesh) stainless soldered (covered) steel screen using a ROTAP® sieve shaker for 15 minutes and the fine fraction (-80 mesh) retained. After each sample, the sieve was cleaned in 4 stages: 1) dust and other particles were brushed out of the sieve and cleaned with compressed air; 2) the sieve was put through an ultrasonic cleaner for 50 minutes to remove any lodged particles; 3) the sieve was then rinsed with deionized water, sprayed with acetone and dried in an oven; and 4) the dried sieve was cleaned with compressed air again. Due to time constraints, some of the humus samples were prepped at ALS Geochemistry in Vancouver. At ALS, the dried and crushed humus samples underwent "PREP-41", where the humus samples were sieved through a 180 µm (80 mesh) sieve.

The <180 µm fraction of humus samples underwent geochemical analyses at the ALS Geochemistry laboratory in Vancouver, BC and at the GSNL geochemistry laboratory, St. John's. At the GSNL laboratory, loss on ignition (LOI) *via* gravimetry (at a temperature of 1000°C) was conducted to quantify organic content, as well as other analyses reported in Hashmi (2023a). At ALS, the sieved (<180 µm; -80 mesh) fraction of humus underwent the following:

1) A 100 g aliquot underwent ashing, where the aliquot is decomposed at 475°C for 24 hours, resulting in an ashed yield of approximately 2 to 4 g. Ashing is advantageous because it can potentially concentrate metals thereby reducing the lower detection limits by an order of magnitude compared to unashed material. The ashed humus sample was then digested in *aqua regia* (1:3 nitric to hydrochloric acid) and analyzed *via* inductively coupled plasma mass spectrometry (ICP-MS) and inductively coupled plasma atomic emission spectroscopy (ICP-AES). A super trace Au detection package was used to determine Au concentration at parts per trillion (ppt) ("ME-VEG41a").

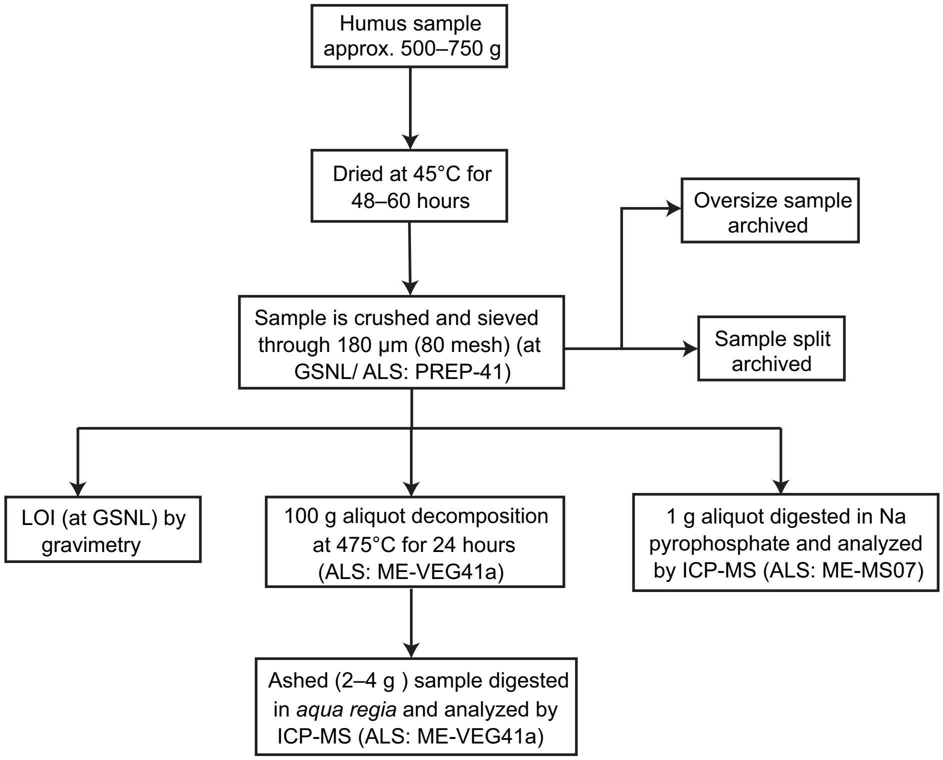


Figure 4. *Flow chart for processing and geochemical analysis of humus samples.*

2) A 1 g aliquot of unashed humus was digested in 25 ml of Na pyrophosphate and mixed for an hour at room temperature (“ME-MS07”) and analyzed by ICP-MS. Sodium pyrophosphate is a partial leach that attacks humic and fulvic acid complexes in organic matter releasing labile elements such as Cu, Pb, Zn, *etc.*, leaving the inorganic fraction relatively unaffected (Hall *et al.*, 1996).

Till

The till samples were all prepared at the GSNL laboratory, St. John’s. The till samples were fully dried in aluminum pans in a Hotpack® oven at 55°C for 48–60 hours (Figure 5). The till samples were returned to their original plastic sample bags and gently crushed with a rubber mallet to break up clumps. The crushed sample (approximately how much 1 kg?) was then sieved through a 63 µm (180 mesh) stainless, solder (covered) steel screen using a ROTAP® sieve shaker and the fine fraction (<63 µm) retained. Prior to sieving the till samples, a 100 g aliquot (<2000 µm) was submitted to Geoscience Laboratories (Geolabs) in Sudbury, Ontario, for particle size analysis (PSA) to determine the percentage of clay (<10 µm), silt (10–63 µm), and sand (63–2000 µm). The sieved (<63 µm) till samples underwent the following:

1) A 50 g aliquot was submitted to the GSNL laboratory for LOI via gravimetry.

The following analyses were completed at ALS Geochemistry:

2) A 300–500 g was submitted for clay separation (2–10 µm; “SCR-CLAY”) and the resulting clay-sized fraction underwent the “ME-MS61” package: a multi-element, ultra-trace method where a 0.25 g aliquot underwent a 4-acid digestion and an ICP-MS finish.

3) A 0.25 g aliquot of <63 µm fraction was analyzed using a 4-acid digestion with ICP-MS and ICP-AES finishes (“ME-MS61L” package).

4) A 50 g aliquot of <63 µm fraction was analyzed using an *aqua regia* digestion and analyzed by ICP-MS using the “AuME-ST44” package.

5) A second 50 g aliquot of <63 µm fraction was analyzed using fire assay and ICP-AES finish (“Au-ICP22” package).

QUALITY ASSURANCE AND QUALITY CONTROL

Similar steps were taken for humus and till samples to ensure quality assurance in the field. To reduce cross-contamination between humus samples, the sampling knife was cleaned thoroughly (and with water where available) prior to sample collection at each site. Similarly, till sampling equip-

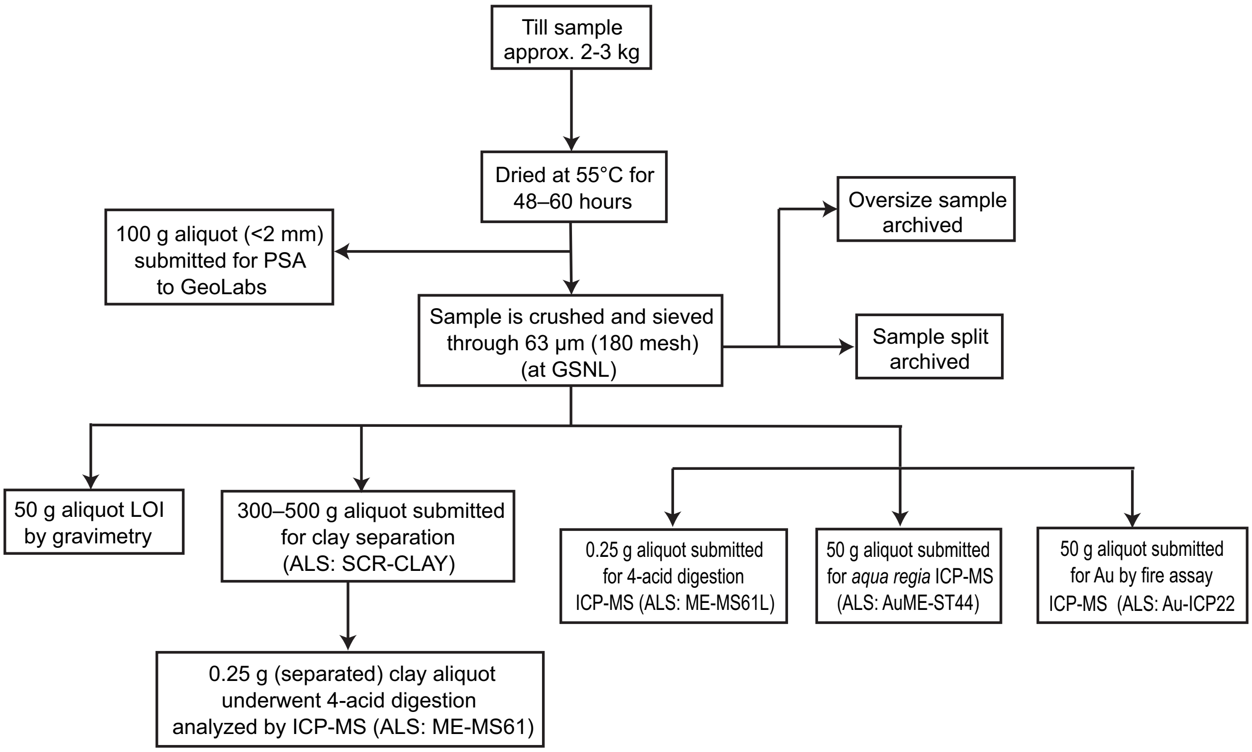


Figure 5. *Flow chart for the processing and geochemical analysis of C-horizon till samples.*

ment was also cleaned between samples to prevent cross-contamination. Each sample bag was labelled, and samples sites were thoroughly photographed to document the sample site.

Quality control measures included insertion of field duplicates for humus that were collected (to determine site variability) approximately every 10 samples, depending on abundance of material and ease of collection. No field duplicates were collected for till samples. No laboratory duplicates or till standards were inserted for till samples at the GSNL laboratory; however, laboratory duplicates for humus samples (prepared by ALS) were inserted to quantify instrumental precision.

PRECISION, ACCURACY AND FIELD VARIABILITY

The analytical precision for humus is calculated by averaging the percent relative standard deviation (Piercey, 2012) of laboratory duplicates that were prepared at ALS and thus considered to be well homogenized. Precision for select elements is calculated from three humus laboratory duplicates that underwent *aqua regia* ICP-MS and five humus laboratory duplicates that underwent Na pyrophosphate (Table 2). The precision for most trace and precious metals is within ±5 to 10%. The precision for Au, (68%), Pd (47%) and Pt (44%) is poor because their concentrations in duplicate pairs are less than the limit of quantification (LOQ), defined as three times the detection limit. Further, Bi (24%), Cu (15%) and Se (55%) by Na pyrophosphate also show poor precision which may also be attributed to low concentrations in duplicate pairs (<LOQ).

Nine humus field duplicates were collected to quantify site variability, determined by calculating the coefficient of variation (Piercey, 2012). For some elements, concentrations measured in one or both duplicate pairs were below detection limits, and therefore removed from calculations; fewer than 9 duplicate pairs were used to calculate the coefficient of variation for some elements (Table 2). The high coefficient of variation for all elements suggests high variability in field duplicates (*i.e.*, high sample heterogeneity). Except Al, B, P, Th and U contents determined by *aqua regia* ICP-MS, all other elements by both *aqua regia* ICP-MS and Na pyrophosphate ICP-MS have >10% coefficient of variance. Further, the loss-on-ignition data shows that some field duplicates have a lower LOI compared to the original sample, suggesting that there is variability in the amount of mineral matter present in field duplicates. The presence of mineral matter in a humus sample may result in higher element content in one field duplicate relative to the other due to partial or complete digestion of mineral matter by *aqua regia*, resulting in discrepancies between element contents in field duplicate samples. High heterogeneity in field duplicates analyzed by Na pyrophosphate ICP-MS may relate to partial dissolution of the humus sample. For most elements, the concentrations are <LOQ, which would also result in a lower coefficient of variation.

Table 2. Calculated precision for humus goechemistry

Element	Method (ICP-MS)	Minimum detection level	No. of laboratory duplicates	Field duplicate variability (CofV)	Element	Method (ICP-MS)	Minimum detection level	No. of laboratory duplicates	Lab duplicates (Avg. %RSD)
Field Duplicates					**Laboratory Duplicates**				
Ag (ppm)	*Aqua regia*	0.001	8	46	Au	*Aqua regia*	0.0002	3	69
As (ppm)	*Aqua regia*	0.01	8	27	Ag	*Aqua regia*	0.001	3	2
Au (ppm)	*Aqua regia*	0.0002	8	57	As	*Aqua regia*	0.01	3	3
Bi (ppm)	*Aqua regia*	0.001	8	18	Bi	*Aqua regia*	0.001	3	6
Cd (ppm)	*Aqua regia*	0.001	8	98	Cd	*Aqua regia*	0.001	3	8
Co (ppm)	*Aqua regia*	0.002	8	92	Co	*Aqua regia*	0.002	3	2
Cu (ppm)	*Aqua regia*	0.01	8	36	Cu	*Aqua regia*	0.01	3	3
Hg (ppm)	*Aqua regia*	0.001	0	All values <DL	Mo	*Aqua regia*	0.01	3	2
Mo (ppm)	*Aqua regia*	0.01	8	13	Ni	*Aqua regia*	0.04	3	3
Ni (ppm)	*Aqua regia*	0.04	8	29	Pb	*Aqua regia*	0.01	3	3
Pb (ppm)	*Aqua regia*	0.01	8	24	Pd	*Aqua regia*	0.001	2	47
Pd (ppm)	*Aqua regia*	0.001	8	21	Pt	*Aqua regia*	0.002	2	44
Pt (ppm)	*Aqua regia*	0.002	8	51	Sb	*Aqua regia*	0.01	3	4
Sb (ppm)	*Aqua regia*	0.01	8	21	Se	*Aqua regia*	0.005	3	6
Se (ppm)	*Aqua regia*	0.005	8	29	Sn	*Aqua regia*	0.01	3	2
Sn (ppm)	*Aqua regia*	0.01	8	26	Te	*Aqua regia*	0.005	3	5
Te (ppm)	*Aqua regia*	0.005	8	30	Zn	*Aqua regia*	0.1	3	3
Zn (ppm)	*Aqua regia*	0.1	8	20	Ag	Na pyrophosphate	0.002	5	5
Ag (ppm)	Na pyrophosphate	0.002	9	25	As	Na pyrophosphate	0.01	5	6
As (ppm)	Na pyrophosphate	0.01	9	52	Bi	Na pyrophosphate	0.003	1	24
Bi (ppm)	Na pyrophosphate	0.003	1	11	Cd	Na pyrophosphate	0.001	5	4
Cd (ppm)	Na pyrophosphate	0.001	9	25	Co	Na pyrophosphate	0.001	5	3
Co (ppm)	Na pyrophosphate	0.001	9	31	Cu	Na pyrophosphate	0.05	5	15
Cu (ppm)	Na pyrophosphate	0.05	9	42	Mo	Na pyrophosphate	0.001	5	9
Fe (ppm)	Na pyrophosphate	1	9	33	Ni	Na pyrophosphate	0.05	4	4
Hg (ppm)	Na pyrophosphate	0.01	5	24	Pb	Na pyrophosphate	0.005	5	2
Mo (ppm)	Na pyrophosphate	0.001	9	27	Sb	Na pyrophosphate	0.0005	5	5
Ni (ppm)	Na pyrophosphate	0.05	3	60	Se	Na pyrophosphate	0.02	4	55
Pb (ppm)	Na pyrophosphate	0.005	9	40	Sn	Na pyrophosphate	0.005	5	8
Sb (ppm)	Na pyrophosphate	0.0005	9	13	Zn	Na pyrophosphate	0.05	5	4
Se (ppm)	Na pyrophosphate	0.02	7	67					
Sn (ppm)	Na pyrophosphate	0.005	9	33					
Te (ppm)	Na pyrophosphate	0.005	1	849					
Zn (ppm)	Na pyrophosphate	0.05	9	29					

Accuracy was measured at ALS using certified reference materials (CRMs): i) OREAS 25a: a mature soil developed over early Tertiary tholeiitic basalt in Victoria, Australia, ii) OREAS 13p: a Ni–Cu–Pt–Pd–Au CRM prepared from reverse circulation drilled sample from western Australia, and iii) OREAS 46: a till collected from an area underlain by Archean greenstone and felsic intrusive rocks near Chibougamau, Quebec). Except for single sample runs for Ag, Al, Co, Mo, that had concentrations lower that the "lower bound" in all three CRMs, and Ho concentrations higher than the upper bound (in OREAS 46), all other element concentrations (in the 3 CRM samples) remained within the predefined upper and lower bounds.

DATA PROCESSING AND VISUALIZATION

The geochemical and LOI% data for humus and till samples is provided in Appendix A and B, respectively. Summary statistics are tabulated in Tables 3 and 4. The complete dataset has been published (*see* Hashmi, 2023b).

Geochemical data were plotted and interpreted in Esri ArcGIS™ (v.10.7.1), Microsoft Excel® and IoGas® software. Before plotting, data below lower detection limits were assigned half the detection value. In cases where element content was reported as "above reporting limit", values assigned were "upper reporting limit" plus "0.1". Spearman correlation matrices were generated (for non-normalized data) for each study site (Jackson's Arm: n = 28, Nipper's Harbour: n = 27 and Glover Island: n = 30) and both *aqua regia* ICP-MS and Na pyrophosphate ICP-MS analyses (Appendix C and D, respectively). The matrices were used to determine correlation between Au, other precious metals, and associated elements. A correlation of r^2>0.70 is considered a significant positive correlation (Appendices C and D). This approach is suitable because element association may vary between each site (*e.g.*, Au may have a stronger correlation with certain elements, depending on the style of mineralization) and each analysis. Mercury and Au concentration by Na pyrophosphate ICP-MS for Glover Island were excluded from the correlation matrix because >10% data were below detection limit, and Pt and

Table 3. Summary statistics for humus data

Element	Method	Sample above detection	Range	Mean	Standard deviation	75th %ile	90th %ile	99th %ile
Nipper's Harbour								
LOI (%)	Gravimetry	27	72.4–97.7	91.27	7.43	97.02	97.47	97.69
Ag (ppm)	Na P ICP-MS	27	0.009–0.034	0.02	0.01	0.02	0.03	0.03
	A.R ICP-MS	27	0.037–7.3	1.34	1.81	1.18	5.58	7.30
As (ppm)	Na P ICP-MS	27	0.02–2.06	0.38	0.46	0.59	0.98	2.06
	A.R ICP-MS	27	9.32–65.5	24.99	11.49	28.90	38.20	65.50
Au (ppm)	Na P ICP-MS	0	NA	NA	NA	NA	NA	NA
	A.R ICP-MS	27	0.01–0.09	0.04	0.03	0.05	0.08	0.10
Bi (ppm)	Na P ICP-MS	7	0.005–0.028	0.01	0.01	0.02	0.03	0.03
	A.R ICP-MS	27	0.223–4.32	1.41	1.12	1.84	3.46	4.32
Cd (ppm)	Na P ICP-MS	27	0.066–0.652	0.23	0.16	0.29	0.57	0.65
	A.R ICP-MS	27	0.808–12	4.71	3.32	6.92	11.35	12.00
Co (ppm)	Na P ICP-MS	27	0.075–4.5	0.68	0.88	0.95	1.43	4.50
	A.R ICP-MS	27	4.88–125.5	22.25	23.01	23.50	40.64	125.50
Cu (ppm)	Na P ICP-MS	27	0.5–25.9	4.17	6.36	4.64	9.96	25.90
	A.R ICP-MS	27	71.3–1420	338.45	330.83	387.00	943.40	1420.00
Hg (ppm)	Na P ICP-MS	26	0.01–0.04	0.02	0.01	0.02	0.04	0.04
	A.R ICP-MS	17	0.001–0.015	0.00	0.00	0.00	0.01	0.02
Mo (ppm)	Na P ICP-MS	27	0.014–0.178	0.05	0.04	0.06	0.12	0.18
	A.R ICP-MS	27	1.36–10.2	4.86	2.55	6.35	9.21	10.20
Ni (ppm)	Na P ICP-MS	26	0.05–4.81	1.03	1.17	1.48	2.89	4.81
	A.R ICP-MS	27	16.5–2950.0	183.54	556.01	88.10	232.80	2950.00
Pb (ppm)	Na P ICP-MS	27	1.735–33.3	9.62	7.07	13.80	17.23	33.30
	A.R ICP-MS	27	25.5–645	238.97	199.13	394.00	584.20	645.00
Pd (ppm)	Na P ICP-MS	20	0.002–0.01	0.01	0.00	0.01	0.01	0.01
Pt (ppm)	A.R ICP-MS	21	0.002–0.007	0.00	0.00	0.01	0.01	0.01
Sb (ppm)	Na P ICP-MS	27	0.02–0.07	0.03	0.01	0.03	0.04	0.07
	A.R ICP-MS	27	0.85–13.15	4.93	3.45	6.92	10.88	13.15
Se (ppm)	Na P ICP-MS	23	0.03–0.72	0.21	0.16	0.28	0.42	0.72
	A.R ICP-MS	27	0.956–20.7	9.53	5.47	13.35	17.44	20.70
Te (ppm)	Na P ICP-MS	18	0.005–0.011	0.01	0.00	0.01	0.01	0.01
	A.R ICP-MS	27	0.019–0.313	0.08	0.06	0.10	0.13	0.31
Zn (ppm)	Na P ICP-MS	27	5.59–87.7	33.73	20.18	39.70	62.40	87.70
	A.R ICP-MS	27	104.5–1860	654.76	442.54	948.00	1224.00	1860.00
Jackson's Arm								
LOI (%)	Gravimetry	26	66.6–98.4	94.4	7.1	97.9	98.2	98.4
Ag (ppm)	Na P ICP-MS	28	0.01–0.07	0.02	0.02	0.02	0.05	0.07
	A.R ICP-MS	28	0.176–36	4.36	7.14	4.17	11.35	36.00
As (ppm)	Na P ICP-MS	28	0.04–36.7	1.55	6.89	0.39	0.81	36.70
	A.R ICP-MS	28	2.41–825	54.07	152.09	34.23	58.45	825.00
Au (ppm)	Na P ICP-MS	1	0.006–0.006	0.01	0.00	0.01	0.01	0.01
	A.R ICP-MS	28	0.0021–0.268	0.03	0.05	0.02	0.03	0.27
Bi (ppm)	Na P ICP-MS	6	0.003–0.011	0.01	0.00	0.01	0.01	0.01
	A.R ICP-MS	28	0.176–5.28	2.24	1.43	3.20	4.39	5.28
Cd (ppm)	Na P ICP-MS	28	0.088–0.63	0.21	0.11	0.26	0.34	0.63
	A.R ICP-MS	28	0.734–18.05	7.13	5.05	8.22	17.01	18.05
Co (ppm)	Na P ICP-MS	28	0.04–2.51	0.26	0.48	0.20	0.67	2.51
	A.R ICP-MS	28	3.25–83.9	11.95	14.62	12.19	18.05	83.90
Cu (ppm)	Na P ICP-MS	28	0.6–3.67	1.07	0.63	1.31	1.71	3.67
	A.R ICP-MS	28	12.9–255	129.09	63.30	186.38	213.20	255.00
Hg (ppm)	Na P ICP-MS	26	0.01–0.04	0.02	0.01	0.02	0.03	0.04
	A.R ICP-MS	12	0.001–0.022	0.01	0.01	0.01	0.02	0.02

Table 3. Continued

Element	Method	Samples above detection	Range	Mean	Standard deviation	75th %ile	90th %ile	99th %ile
Jackson's Arm (continued)								
Mo (ppm)	Na P ICP-MS	28	0.008–0.365	0.04	0.07	0.05	0.08	0.37
	A.R ICP-MS	28	0.99–10.4	5.96	2.71	7.92	9.86	10.40
Ni (ppm)	Na P ICP-MS	10	0.05–0.34	0.18	0.10	0.28	0.34	0.34
	A.R ICP-MS	28	5.92–160.5	40.87	26.89	47.38	59.11	160.50
Pb (ppm)	Na P ICP-MS	28	2.8–30.4	11.72	6.52	16.54	20.88	30.40
	A.R ICP-MS	28	38.4–699	384.39	195.51	525.50	679.90	699.00
Pd (ppm)	Na P ICP-MS	8	0.001–0.009	0.01	0.00	0.01	0.01	0.01
Pt (ppm)	A.R ICP-MS	27	0.002–0.008	0.00	0.00	0.01	0.01	0.01
Sb (ppm)	Na P ICP-MS	27	0.02–0.07	0.03	0.01	0.03	0.04	0.07
	A.R ICP-MS	27	0.85–13.15	4.93	3.45	6.92	10.88	13.15
Se (ppm)	Na P ICP-MS	23	0.03–0.72	0.21	0.16	0.28	0.42	0.72
	A.R ICP-MS	27	0.956–20.7	9.53	5.47	13.35	17.44	20.70
Te (ppm)	Na P ICP-MS	18	0.005–0.011	0.01	0.00	0.01	0.01	0.01
	A.R ICP-MS	27	0.019–0.313	0.08	0.06	0.10	0.13	0.31
Zn (ppm)	Na P ICP-MS	27	5.59–87.7	33.73	20.18	39.70	62.40	87.70
	A.R ICP-MS	27	104.5–1860	654.76	442.54	948.00	1224.00	1860.00
Glover Island								
LOI (%)	Gravimetry	30	73.7–98.9	94.84	5.69	98.34	98.84	98.94
Ag (ppm)	Na P ICP-MS	31	0.007–0.079	0.02	0.02	0.02	0.05	0.08
	A.R ICP-MS	28	1.19–21	5.27	4.57	6.88	13.05	21.00
As (ppm)	Na P ICP-MS	31	0.02–19.05	0.96	3.37	0.47	0.85	19.05
	A.R ICP-MS	28	9.48–101.5	35.98	20.74	48.28	61.26	101.50
Au (ppm)	Na P ICP-MS	1	0.01–0.01	0.01	0.00	0.01	0.01	0.01
	A.R ICP-MS	28	0.0034–8.47	0.37	1.60	0.04	0.59	8.47
Bi (ppm)	Na P ICP-MS	13	0.003–0.078	0.02	0.02	0.02	0.06	0.08
	A.R ICP-MS	28	0.56–5.71	2.58	1.38	3.73	4.71	5.71
Cd (ppm)	Na P ICP-MS	31	0.148–0.982	0.45	0.22	0.57	0.77	0.98
	A.R ICP-MS	28	1.67–34.3	14.85	8.83	21.18	29.77	34.30
Co (ppm)	Na P ICP-MS	31	0.075–1.99	0.56	0.52	0.83	1.47	1.99
	A.R ICP-MS	28	3.45–69.2	25.53	16.17	35.70	47.92	69.20
Cu (ppm)	Na P ICP-MS	31	0.18–5.05	1.33	1.21	1.49	3.61	5.05
	A.R ICP-MS	28	22.8–5820.0	334.15	1077.5	199.0	269.0	5820.0
Hg (ppm)	Na P ICP-MS	23	0.01–0.09	0.02	0.02	0.02	0.05	0.09
	A.R ICP-MS	21	0.001–0.014	0.00	0.00	0.01	0.01	0.01
Mo (ppm)	Na P ICP-MS	31	0.01–-3.37	0.16	0.60	0.07	0.18	3.37
	A.R ICP-MS	28	1.66–31.9	7.85	5.46	9.71	11.57	31.90
Ni (ppm)	Na P ICP-MS	26	0.12–4.15	0.76	0.89	0.93	1.98	4.15
	A.R ICP-MS	28	23.8–190	84.72	47.67	107.88	179.05	190.00
Pb (ppm)	Na P ICP-MS	31	0.388–40.2	16.32	12.35	26.70	35.20	40.20
	A.R ICP-MS	28	117.5–1645	601.71	392.08	847.25	1307.00	1645.00
Pd (ppm)	Na P ICP-MS	20	0.002–0.015	0.01	0.00	0.01	0.01	0.02
Pt (ppm)	A.R ICP-MS	26	0.002–0.049	0.01	0.01	0.02	0.03	0.05
Sb (ppm)	Na P ICP-MS	31	0.019–0.099	0.03	0.02	0.03	0.05	0.10
	A.R ICP-MS	28	0.78–16.8	8.31	4.52	12.25	15.42	16.80
Se (ppm)	Na P ICP-MS	29	0.03–2.56	0.35	0.46	0.39	0.63	2.56
	A.R ICP-MS	28	2.6–35	15.80	8.81	24.03	26.74	35.00
Te (ppm)	Na P ICP-MS	17	0.005–0.017	0.01	0.00	0.01	0.01	0.02
	A.R ICP-MS	28	0.015–3.38	0.22	0.63	0.12	0.22	3.38
Zn (ppm)	Na P ICP-MS	31	7.41–60.5	24.81	13.61	32.00	46.24	60.50
	A.R ICP-MS	28	105.5–1335	764.43	376.93	1133.75	1270.00	1335.00

Note: Na P = Na pyrophosphate; A.R = *Aqua regia*

Table 4. Summary statistics for till data

Element	Size fraction	Method	Samples above detection	Range	Mean	Standard deviation	75th %ile	90th %ile	99th %ile
Jackson's Arm									
Ag (ppm)	Clay	ME-MS61™	1	0.17	0.17	0.00	0.17	0.17	0.17
	Silt+Clay	ME-MS61L™	4	0.02–0.15	0.07	0.06	0.13	0.15	0.15
	Silt+Clay	AuME-ST44™	4	0.013–0.075	0.040	0.030	0.070	0.080	0.080
As (ppm)	Clay	ME-MS61™	1	213	213	0	213	213	213
	Silt+Clay	ME-MS61L™	4	17.40–390.00	123.23	178.93	307.95	390.00	390.00
	Silt+Clay	AuME-ST44™	4	17.10–239.00	83.73	105.31	194.08	239.00	239.00
Au (ppm)	Silt+Clay	Au-ICP22	5	0.002–0.371	0.090	0.160	0.210	0.370	0.370
	Silt+Clay	AuME-ST44™	4	0.003–0.0624	0.02	0.03	0.05	0.06	0.06
Bi (ppm)	Clay	ME-MS61™	1	0.23	0.23	0.00	0.23	0.23	0.23
	Silt+Clay	ME-MS61L™	4	0.027–0.101	0.060	0.040	0.100	0.100	0.100
	Silt+Clay	AuME-ST44™	4	0.0173–0.0875	0.0600	0.0300	0.0800	0.0900	0.0900
Cd (ppm)	Clay	ME-MS61™	1	0.21	0.21	0.00	0.21	0.21	0.21
	Silt+Clay	ME-MS61L™	4	0.084–0.137	0.120	0.020	0.130	0.140	0.140
	Silt+Clay	AuME-ST44™	4	0.042–0.09	0.060	0.020	0.080	0.090	0.090
Co (ppm)	Clay	ME-MS61™	1	52.90	52.90	0.00	52.90	52.90	52.90
	Silt+Clay	ME-MS61L™	4	10.85–25.10	16.98	5.94	22.89	25.10	25.10
	Silt+Clay	AuME-ST44™	4	3.37–23.60	12.03	8.54	20.76	23.60	23.60
Cu (ppm)	Clay	ME-MS61™	1	233	2330	0.00	2330	2330	2330
	Silt+Clay	ME-MS61L™	4	18.40–54.80	35.08	16.65	51.72	54.80	54.80
	Silt+Clay	AuME-ST44™	4	6.92–60.80	33.93	24.79	57.60	60.80	60.80
Hg (ppm)	Clay	ME-MS61™	5	0.043–4.500	3.610	1.990	4.500	4.500	4.500
	Silt+Clay	AuME-ST44™	4	0.004–0.178	0.110	0.080	0.170	0.180	0.180
Mo (ppm)	Clay	ME-MS61™	1	1.86	1.86	0.00	1.86	1.86	1.86
	Silt+Clay	ME-MS61L™	4	1.09–5.69	2.58	2.10	4.73	5.69	5.69
	Silt+Clay	AuME-ST44™	4	1.00–5.05	2.63	1.77	4.48	5.05	5.05
Ni (ppm)	Clay	ME-MS61™	1	87	87	0	87	87	87
	Silt+Clay	ME-MS61L™	4	9.43–36.20	18.45	12.32	31.48	36.20	36.20
	Silt+Clay	AuME-ST44™	4	3.65–31.10	13.11	12.36	26.08	31.10	31.10
Pb (ppm)	Clay	ME-MS61™	1	124	124	0	124	124	124
	Silt+Clay	ME-MS61L™	4	18.20–58.30	36.53	16.56	52.88	58.30	58.30
	Silt+Clay	AuME-ST44™	4	10.35–116.00	45.51	47.71	94.10	116.00	116.00
Pd (ppm)	Silt+Clay	AuME-ST44™	0	NA	NA	NA	NA	NA	NA
Pt (ppm)	Silt+Clay	AuME-ST44™	4	0.001–0.003	0.000	0.000	0.000	0.000	0.000
Sb (ppm)	Clay	ME-MS61™	1	1.31	1.31	0.00	1.31	1.31	1.31
	Silt+Clay	ME-MS61L™	4	0.08–0.76	0.36	0.31	0.68	0.76	0.76
	Silt+Clay	AuME-ST44™	4	0.035–0.249	0.15	0.09	0.23	0.25	0.25
Se (ppm)	Clay	ME-MS61™	1	1	1	0	1	1	1
	Silt+Clay	ME-MS61L™	4	0.05–2.76	1.19	1.22	2.46	2.76	2.76
	Silt+Clay	AuME-ST44™	4	0.061–2.59	1.68	1.16	2.55	2.59	2.59
Te (ppm)	Clay	ME-MS61™	1	0.11–0.11	0.11	0.00	0.11	0.11	0.11
	Silt+Clay	ME-MS61L™	4	0.017–0.304	0.09	0.14	0.23	0.30	0.30
	Silt+Clay	AuME-ST44™	4	0.016–0.047	0.03	0.01	0.04	0.05	0.05
Zn (ppm)	Clay	ME-MS61™	1	446	446	0	446	446	446
	Silt+Clay	ME-MS61L™	4	99.00–200.00	142.63	42.13	185.00	200.00	200.00
	Silt+Clay	AuME-ST44™	4	36.70–175.50	99.50	57.95	157.75	175.50	175.50

Table 4. Continued

Element	Size fraction	Method	Samples above detection	Range	Mean	Standard deviation	75th %ile	90th %ile	99th %ile
Glover Island									
Ag (ppm)	Clay	ME-MS61™	3	0.09–0.44	0.26	0.18	0.44	0.44	0.44
	Silt+Clay	ME-MS61L™	3	0.016–0.072	0.04	0.03	0.07	0.07	0.07
	Silt+Clay	AuME-ST44™	3	0.012–0.071	0.04	0.03	0.07	0.07	0.07
As (ppm)	Clay	ME-MS61™	3	37.1–128.5	70.03	50.77	128.50	128.50	128.50
	Silt+Clay	ME-MS61L™	3	8.92–42	20.46	18.67	42.00	42.00	42.00
	Silt+Clay	AuME-ST44™	3	4.2–39.2	17.20	19.15	39.20	39.20	39.20
Au (ppm)	Silt+Clay	Au-ICP22	2	0.004–0.011	0.01	0.00	0.01	0.01	0.01
	Silt+Clay	AuME-ST44™	3	0.0041–0.0053	0.00	0.00	0.01	0.01	0.01
Bi (ppm)	Clay	ME-MS61™	3	0.15–0.52	0.28	0.21	0.52	0.52	0.52
	Silt+Clay	ME-MS61L™	3	0.052–0.113	0.08	0.03	0.11	0.11	0.11
	Silt+Clay	AuME-ST44™	3	0.046–0.0765	0.06	0.02	0.08	0.08	0.08
Cd (ppm)	Clay	ME-MS61™	3	0.23–0.97	0.59	0.37	0.97	0.97	0.97
	Silt+Clay	ME-MS61L™	3	0.133–0.317	0.21	0.10	0.32	0.32	0.32
	Silt+Clay	AuME-ST44™	3	0.108–0.296	0.18	0.10	0.30	0.30	0.30
Co (ppm)	Clay	ME-MS61™	3	15.7–66.7	40.40	25.54	66.70	66.70	66.70
	Silt+Clay	ME-MS61L™	3	20–28.5	23.13	4.67	28.50	28.50	28.50
	Silt+Clay	AuME-ST44™	3	14.65–24.5	17.98	5.64	24.50	24.50	24.50
Cu (ppm)	Clay	ME-MS61™	3	112.5–177.5	148.83	33.17	177.50	177.50	177.50
	Silt+Clay	ME-MS61L™	3	42.5–51.5	47.93	4.78	51.50	51.50	51.50
	Silt+Clay	AuME-ST44™	3	40.6–54.4	48.87	7.29	54.40	54.40	54.40
Hg (ppm)	Clay	ME-MS61™	3	0.378–4.5	3.13	2.38	4.50	4.50	4.50
	Silt+Clay	AuME-ST44™	3	0.061–0.213	0.12	0.08	0.21	0.21	0.21
Mo (ppm)	Clay	ME-MS61™	3	1.44–3.3	2.47	0.95	3.30	3.30	3.30
	Silt+Clay	ME-MS61L™	3	0.42–0.86	0.60	0.23	0.86	0.86	0.86
	Silt+Clay	AuME-ST44™	3	0.315–0.84	0.51	0.28	0.84	0.84	0.84
Ni (ppm)	Clay	ME-MS61™	3	53.3–258	148.10	103.18	258.00	258.00	258.00
	Silt+Clay	ME-MS61L™	3	57.4–152	99.33	48.20	152.00	152.00	152.00
	Silt+Clay	AuME-ST44™	3	41.4–100.5	65.37	31.09	100.50	100.50	100.50
Pb (ppm)	Clay	ME-MS61™	3	16.2–66.5	33.50	28.59	66.50	66.50	66.50
	Silt+Clay	ME-MS61L™	3	7.44–13.5	9.96	3.16	13.50	13.50	13.50
	Silt+Clay	AuME-ST44™	3	4.85–10.05	6.71	2.90	10.05	10.05	10.05
Pd (ppm)	Silt+Clay	AuME-ST44™	0	NA	NA	NA	NA	NA	NA
Pt (ppm)	Silt+Clay	AuME-ST44™	3	0.002–0.003	0.00	0.00	0.00	0.00	0.00
Sb (ppm)	Clay	ME-MS61™	3	1.09–3.21	2.00	1.09	3.21	3.21	3.21
	Silt+Clay	ME-MS61L™	3	0.93–1.58	1.26	0.33	1.58	1.58	1.58
	Silt+Clay	AuME-ST44™	3	0.323–0.402	0.37	0.04	0.40	0.40	0.40
Se (ppm)	Clay	ME-MS61™	3	4–5	4.33	0.58	5.00	5.00	5.00
	Silt+Clay	ME-MS61L™	3	0.583–1.19	0.82	0.33	1.19	1.19	1.19
	Silt+Clay	AuME-ST44™	3	0.357–1.19	0.68	0.45	1.19	1.19	1.19
Te (ppm)	Clay	ME-MS61™	3	0.07–0.19	0.12	0.06	0.19	0.19	0.19
	Silt+Clay	ME-MS61L™	3	0.013–0.029	0.02	0.01	0.03	0.03	0.03
	Silt+Clay	AuME-ST44™	3	0.013–0.019	0.02	0.00	0.02	0.02	0.02
Zn (ppm)	Clay	ME-MS61™	3	49–130	96.33	42.19	130.00	130.00	130.00
	Silt+Clay	ME-MS61L™	3	57.9–66.6	61.97	4.38	66.60	66.60	66.60
	Silt+Clay	AuME-ST44™	3	41.4–43.7	42.57	1.15	43.70	43.70	43.70

Pd were not analyzed by Na pyrophosphate ICP-MS. The correlation matrix for data by Na pyrophosphate ICP-MS was still useful in determining the relationship between other base metals (*e.g.*, Cu, Fe, Ni, Pb and Zn) and associated elements. XY-plots were generated for select precious metals and associated/correlated elements by both analyses against LOI% (Appendix E). Humus data are plotted as percentiles using proportionally sized dot plots, where <50th percentile is considered "background", 50th to 75th percentile is considered "elevated", 76th to 90th percentile is considered anomalous and >90th percentile is considered highly anomalous. Of the field and laboratory duplicate sample data, the sample with the higher element content is plotted and discussed. Minor- and trace-element data are reported in ppm (parts per million) and major-element data are reported in wt. % (weight percent). Ore and select pathfinder elements for all eight till samples are plotted as coloured dot plots as well.

RESULTS AND DISCUSSION

HUMUS ELEMENT ASSOCIATIONS AND SPATIAL CORRELATIONS

In the Jackson's Arm map area, Au does not show a significant ($r^2 > 0.70$) correlation with any other element; however, Au shows a weak ($r^2 < 0.70$) correlation with Te. Silver shows a weak correlation with Cu, Te and Se. Similarly, Pd and Pt also do not show strong correlation with any other elements. Spatial, proportional dot plots show that at the Shrik, Stocker and Boot n Hammer Au occurrences, humus samples with anomalous to highly anomalous Au also contain elevated to highly anomalous Ag, As, Bi, Cu, Mo, Ni, Pb, S, Sb, Sn, Te and Zn, whereas at the Rattling Brook deposit, samples with anomalous to highly anomalous Au also contain elevated to highly anomalous Ag, As, Co, and Mo.

Similarly, in the Nippers Harbour map area, Au has no significant correlation with other elements but has a weak correlation with Cu. Conversely, spatial, proportional dot plots show that samples with anomalous to highly anomalous Au content also have anomalous to highly anomalous Ag, As, Cr, Cu, In, Mo, Ni and Pd. Palladium also does not show a strong correlation with any other element, whereas Pt shows a strong correlation with Se. Silver shows a strong correlation with V in both analyses, and Ag by Na pyrophosphate ICP-MS also shows a strong positive correlation with In, Mo, Sn, U and Zr.

At Glover Island, Au shows a strong correlation with Se, Te, S, Ge and Sr, and Ag shows a strong correlation with Zn (Ag analyzed by Na pyrophosphate ICP-MS shows a positive correlation with several elements including As, Cr, Bi, In, Sn and Mo). Palladium does not show a strong correlation with any other element, whereas Pt shows a strong correlation with Re, S, P and K. Spatial, proportional dot plots show that samples with anomalous to highly anomalous Au content also have anomalous to highly anomalous As, Bi, Co, Cd, Cr, Hg, Mo, Ni, Pb, Pd, Pt, S, Sb, Se, Sn, Te and Zn.

HUMUS GEOCHEMICAL SIGNATURE

Jackson's Arm Map Area

Humus was noted to contain "woody," and "rooty" components as well as "conifer needles" and was sampled where it overlay outcrop, till or boulders. Humus is moderately to well-developed in the Jackson's Arm map area, (*i.e.*, thickly developed, abundant humified material, little to no mixing of the underlying soil horizons) and its thickness ranges from 5–25 cm and no charcoal was noted in any of the samples (Hashmi, 2023b). The LOI of humus samples in the Jackson's Arm map area ranges 67–98%; the average LOI is 94%, meaning that, on average, 6% of the humus sample comprised mineral (and other inorganic matter; Table 3). Only one sample was described as poorly developed and also returned a LOI of 86% (Figure 6). Generally, better developed humus (*i.e.*, moderately- to well-developed) correlates with higher LOI (>85%) and poorly developed humus correlates with lower LOI (<85%), suggesting higher amount of mineral matter within sample. The lowest LOI (66%) was from a moderately-developed humus sample collected <50 m east of the regional road.

Although care was taken during humus sample collection to ensure that none of the underlying mineral matter from the lower soil horizons was included in the sample, the LOI data suggests that some mineral matter from the underlying soil horizons may have been unavoidably sampled. The high amount of mineral matter in one sample from Jackon's Arm (34%) may also be attributed to anthropogenic sources, such as dust from paved and unpaved regional and forestry roads, and ATV trails, and or greenfields exploration activities in the area including geophysical surveys, soil sampling and trenching. The dominant wind direction in the Jackson's Arm map area is to the south, southwest; however, there is limited infrastructure development and mining activity in the region upwind from the sampling sites that could potentially contribute to the anthropogenic signature in humus. It is likely that any anthropogenic input into the humus geochemistry is associated with regional roads and highway and infrastructure development. Another potential source of contamination may be greenfields exploration activity in the vicinity of the Rattling Brook deposit (Apsy Zone and Road Zone developed prospect and Beaver Dam showing) as well as other prominent Au occurrences in the area, including the Boot n Hammer, Stocker and Shrik Au showings that are less than a kilometre away.

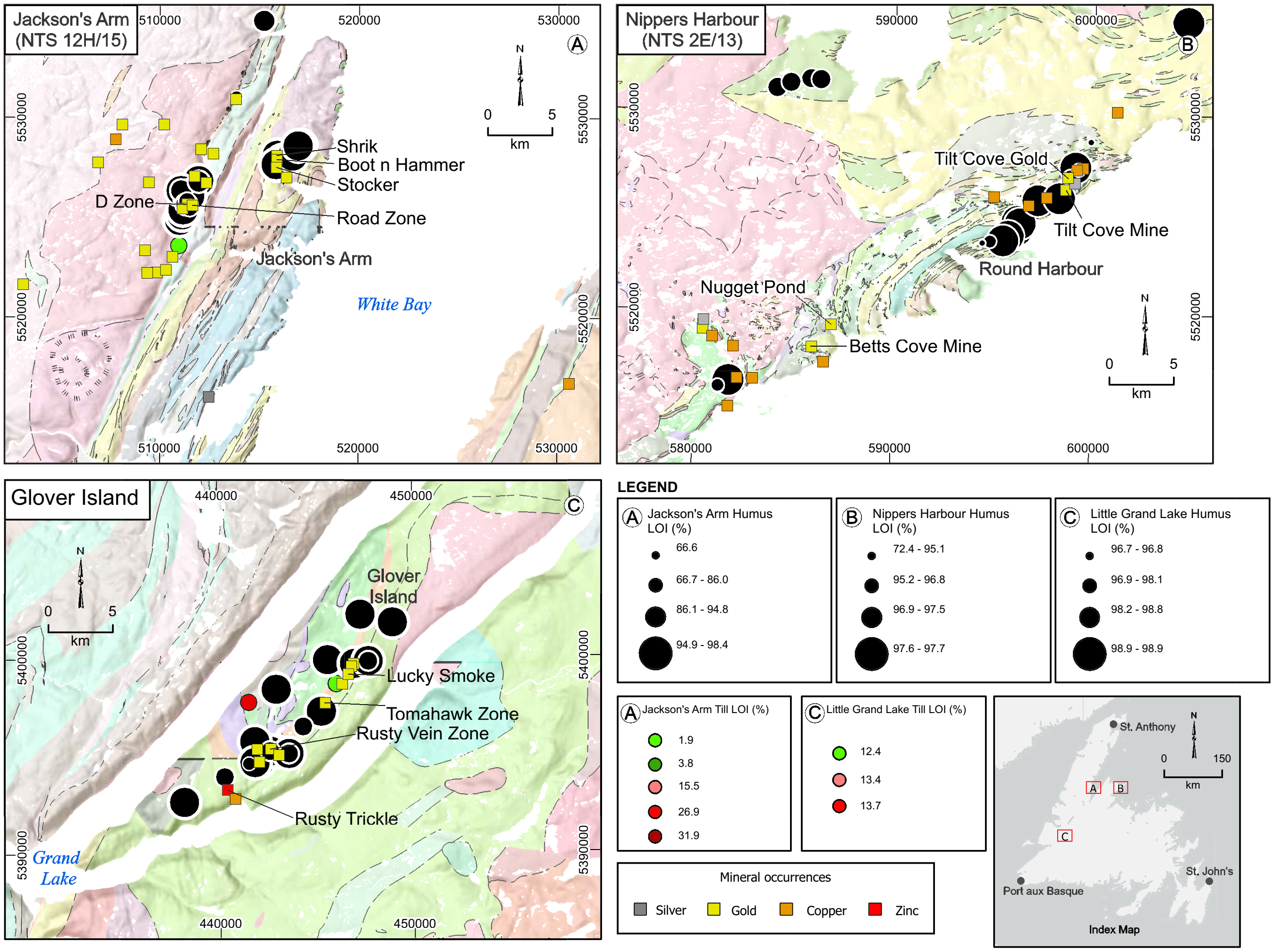


Figure 6. *Proportional dot plots for LOI% values for humus and till samples.*

Nippers Harbour Map Area

Humus samples in the Nippers Harbour map area are described as poorly to moderately developed (*i.e.*, thinly developed, extremely rooty, lack of humified material, some mixing of the underlying soil horizons). The humus thickness ranges from 2–15 cm and only five samples of the 27 samples collected are described as well-developed. The LOI content of humus samples in the Nippers Harbour map area ranges from 72–98%; the average LOI is 91% (Table 3; Figure 6). Most humus samples were collected from a thin, poorly developed humus (<5 cm) near former mines, near ATV trails or previous diamond-drill sites, therefore it is not unexpected that most of the samples contain "dust" (identified by its gritty texture).

Sources of anthropogenic contamination in the Nippers Harbour map area include airborne dust from regional roads during transportation of ore- and mining-materials from past- and currently-producing (at the time of sampling: July 2022) mines in the region (*e.g.*, Nugget Pond Au Mine), contamination from anthropogenic activities such as infrastructure construction associated with the Nugget Pond Mine (road, mine, and building construction). Abandoned mining and drilling equipment were noted near sampling sites in the Nippers Harbour map area, which is indicative of exploration activity and consequently a disturbed soil horizon and poorly developed humus. The dominant wind direction in the Nippers Harbour map area varies from south, southeast to south, southwest (Windfinder, 2024). The humus sampling sites were purposely positioned upwind of the Nugget Pond Mine. Thus, humus should be minimally affected by fine (silt-sized) windblown particles from the Nugget Pond Mine mining operations, assaying, and windblown tailings.

Glover Island

Humus thickness ranged from 4–40 cm (Hashmi, 2023) and the LOI content of humus samples collected on Glover Island range 74–99% (average LOI: 95%), suggesting a thick, organic-rich, well-developed O-horizon with minimal anthropogenic fall out (Table 3). No charcoal was noted in any samples either. Also, most humus samples were collected overlying bedrock. Glover Island is the least inhabited/affected by anthropogenic influences of all three study areas and most humus samples collected there were described as well-developed. The main sources of anthropogenic contamination on Glover Island are greenfields exploration near Au occurrences; old core storage shacks were noted near some humus sampling sites on Glover Island. The dominant wind direction on Glover Island is to the west, southwest (Windfinder, 2024). Corner Brook, which is the closest and largest town is situated west, northwest of Glover Island is therefore, upwind of it. It is unlikely that wind-blown anthropogenic particles from Corner Brook or other nearby towns have affected the humus geochemistry.

COMPARISON BETWEEN *AQUA REGIA* ICP-MS AND Na PYROPHOSPHATE ICP-MS

A comparison of humus geochemical results determined by Na pyrophosphate ICP-MS and *aqua regia* ICP-MS relative to LOI% is a valid approach for determining naturally occurring (within humus) *versus* contaminant derived anomalies (*e.g.*, accidental sampling of the underlying mineral soil horizon; Figures 7–10; Appendix E). If an anomaly in humus is contaminant-related, the sample would likely have lower LOI% (<95%) due to higher mineral soil or other contaminant content, elevated element contents determined by *aqua regia* ICP-MS but lower (even background) contents by Na pyrophosphate ICP-MS. By contrast, naturally occurring geochemical anomalies in humus samples would be characterized by higher LOI% (>95%), and elevated to high metal concentrations by both *aqua regia* ICP-MS and Na pyrophosphate ICP-MS. Generally, humus samples with elevated to anomalous Au and associated element contents by *aqua regia* ICP-MS show the same pattern by Na pyrophosphate ICP-MS. This similarity suggests that most anomalous element concentrations reflect naturally occurring anomalies, which may include mineral soil associated with mineralized glacially dispersed tills.

Compared to Na pyrophosphate ICP-MS, element concentrations by *aqua regia* ICP-MS are tens to hundreds of times higher at all three sites. This greater concentration for *aqua regia* values is a function of: 1) *aqua regia* being a stronger leach than Na pyrophosphate that can completely digest organic matter, as well as sulphide and oxide minerals, thereby resulting in higher element concentrations (ALS Geochemistry, 2022) and 2) preconcentration of metals in humus by ashing of humus prior to *aqua regia* digestion. The Na pyrophosphate digestion targets elements bound specifically to the humic and fulvic acid complexes, but does not dissolve inorganic matter, resulting in much lower absolute concentrations. However, this selective element adsorption and release from humic and fulvic acid complexes enhances the anomaly to background contrast (Henderson *et al.*, 1998). The correlation between elements analyzed by Na pyrophosphate ICP-MS and *aqua regia* ICP-MS is variable. In some elements, such as Ag, As, Co, Cd, Pb (Jackson's Arm map area), Pb, Ni, Co, Cd, Ag (Nippers Harbour map area) and Pb, Cd, Co, Cu, Ni (Glover Island), there is generally a positive correlation between the results by both analyses. Conversely, in other elements, such as Ni, Mo, Cu, Ni, Sb, Hg, Bi (Jackson's Arm map area), Hg, As, Bi, Cu, Mo, Sb (Nippers Harbour map area) and Mo, Ag, As, Bi, Hg, Sb, Cu, Ag (Glover Island), there is no correlation between element concentrations reported from one method versus the other. Further, lower LOI% corresponds to higher element concentrations measured by *aqua regia* ICP-MS than Na pyrophosphate ICP-MS. This difference suggests that contaminants (*e.g.*, dust or mineral matter) within the sample that can be dissolved by *aqua regia* but not Na pyrophosphate may contribute to the overall geochemical signature of the sample. The results show that there is poor correlation between LOI and geochemical concentrations (*i.e.*, not all low LOI values correspond to high-element content suggesting that high-element content is associated with contaminants). High LOI% and high-element contents in samples suggests that in some cases, high-element values may be associated with naturally occurring anomalies and not a result of anthropogenic contamination.

REGIONAL COMPOSITIONAL TRENDS

Proportional dot plots were generated for Au, Ag, Pt and Pd, and associated elements (based on the literature review) for humus and till data in Figures 11–20 and in Appendices F and G.

HUMUS GEOCHEMISTRY

Jackson's Arm Map Area

In the Jackson's Arm map area, elevated to highly anomalous Au concentrations occur in humus samples collected near Au occurrences, digested by *aqua regia* and by Na pyrophosphate. Background Au content (*i.e.*, <50th %ile) ranges 0.002 to 0.014 ppm for *aqua regia* and <0.001 ppm for Na pyrophosphate. The highest Au content (0.268 ppm by *aqua regia* and 0.006 ppm by Na pyrophosphate; Figures 11 and 12) is in humus sample 2022-SH111-2011, collected <50 m from the D Zone Au mineralization. Elevated to highly anomalous Au content is also present in humus samples collected in the vicinity of the Shrik, Stocker and Boot n Hammer Au showings. Similarly, elevated to highly anomalous Ag content (up to 36 ppm by *aqua regia* in 2022-SH111-2019 and 0.074 ppm by Na pyrophosphate in 2022-SH111-2011; Figures 13 and 14) is also present in humus samples in the vicinity of D

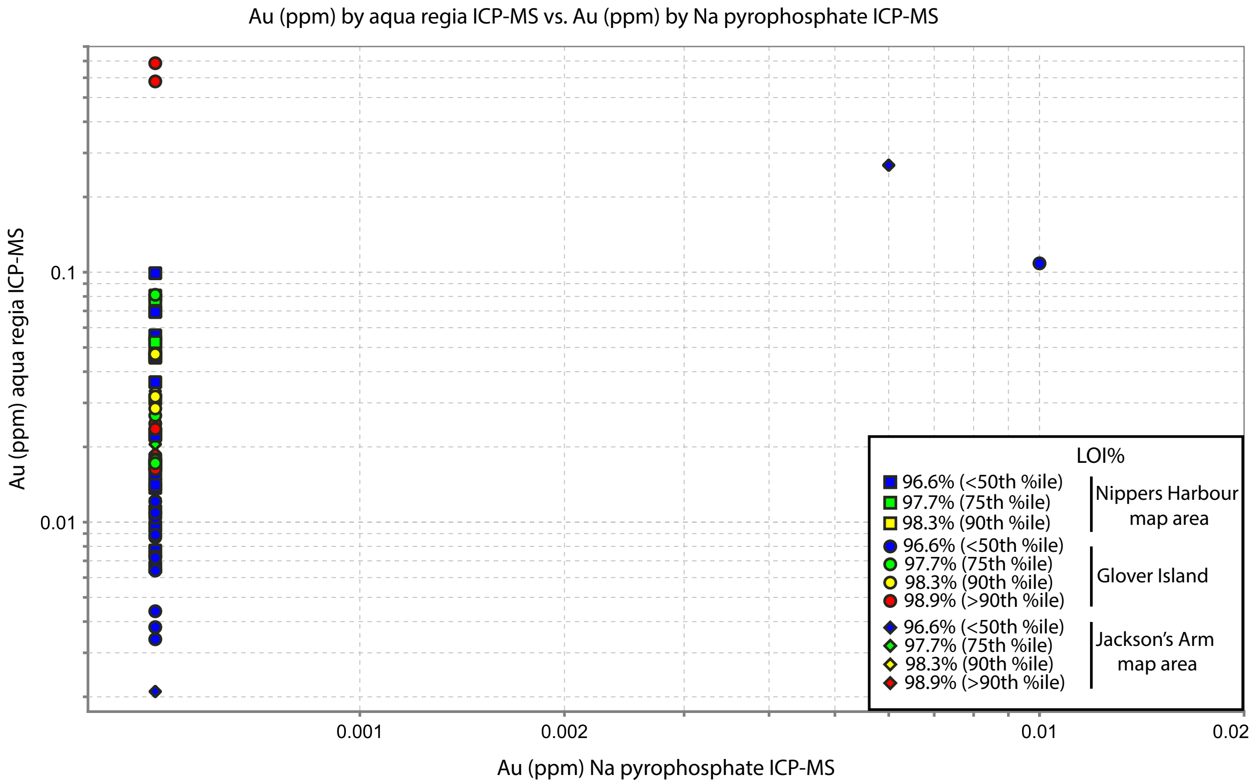


Figure 7. *XY plots for Au analyzed by* aqua regia *ICP-MS* versus *Na pyrophosphate ICP-MS.*

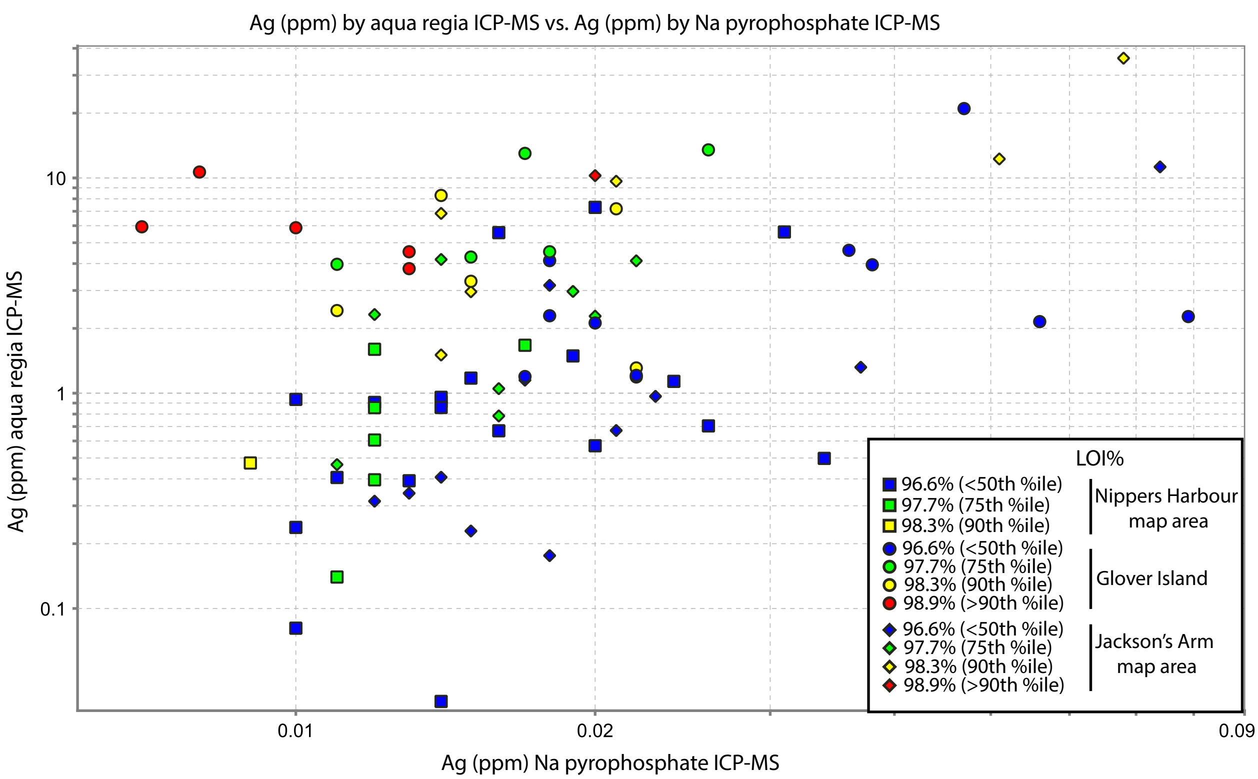


Figure 8. *XY plots for Ag analyzed by* aqua regia *ICP-MS* versus *Na pyrophosphate ICP-MS.*

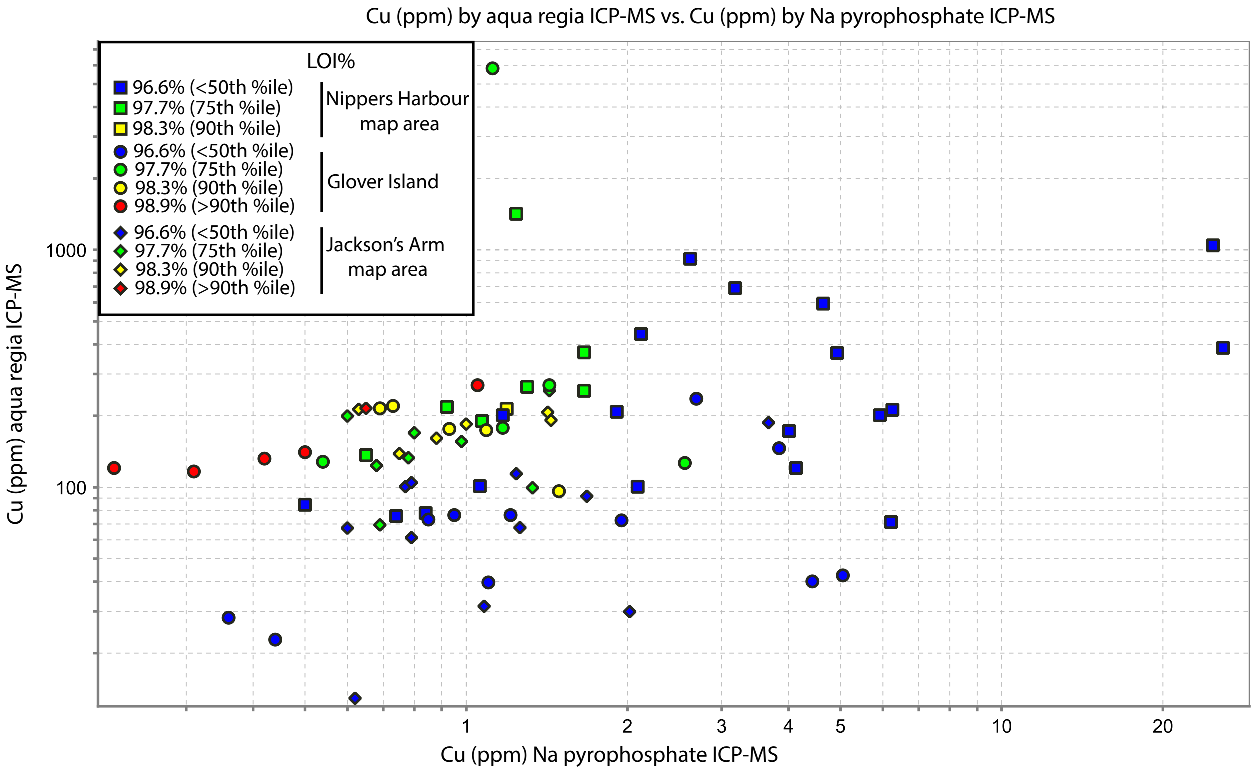


Figure 9. *XY plots for Cu analyzed by* aqua regia *ICP-MS* versus *Na pyrophosphate ICP-MS.*

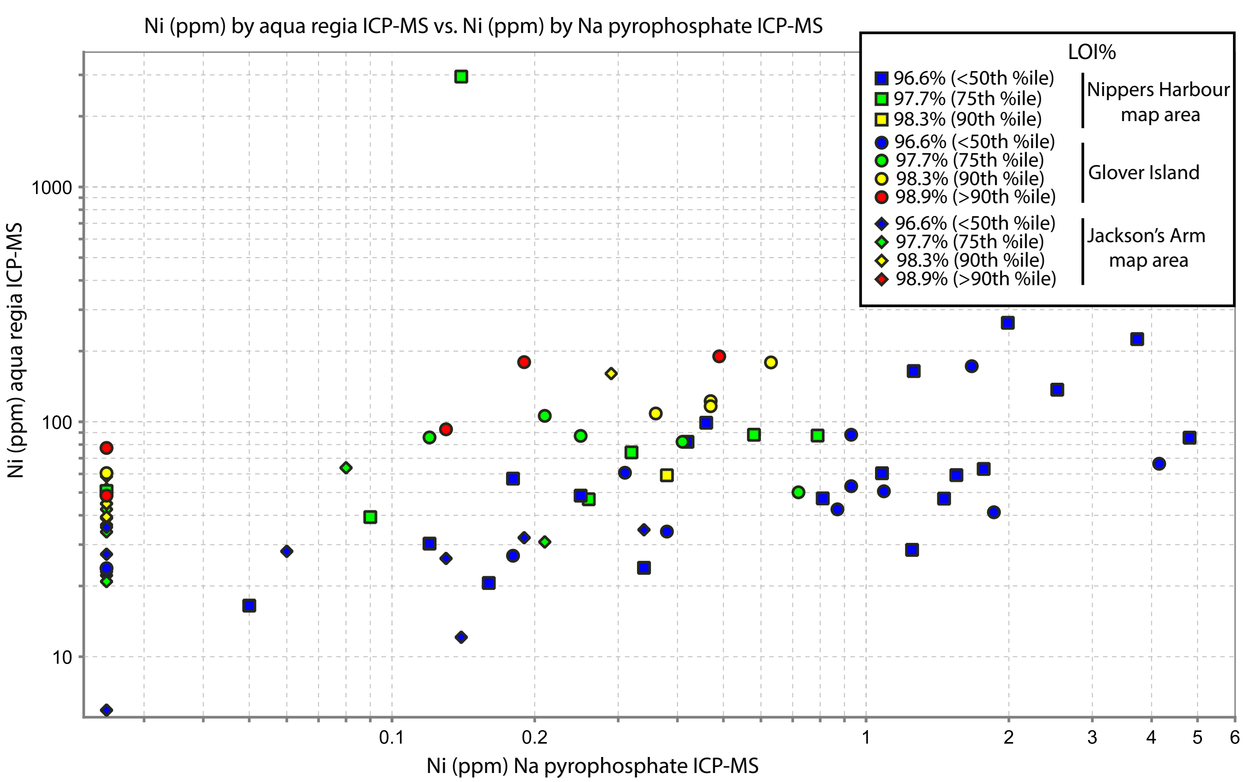


Figure 10. *XY plots for Ni analyzed by* aqua regia *ICP-MS* versus *Na pyrophosphate ICP-MS.*

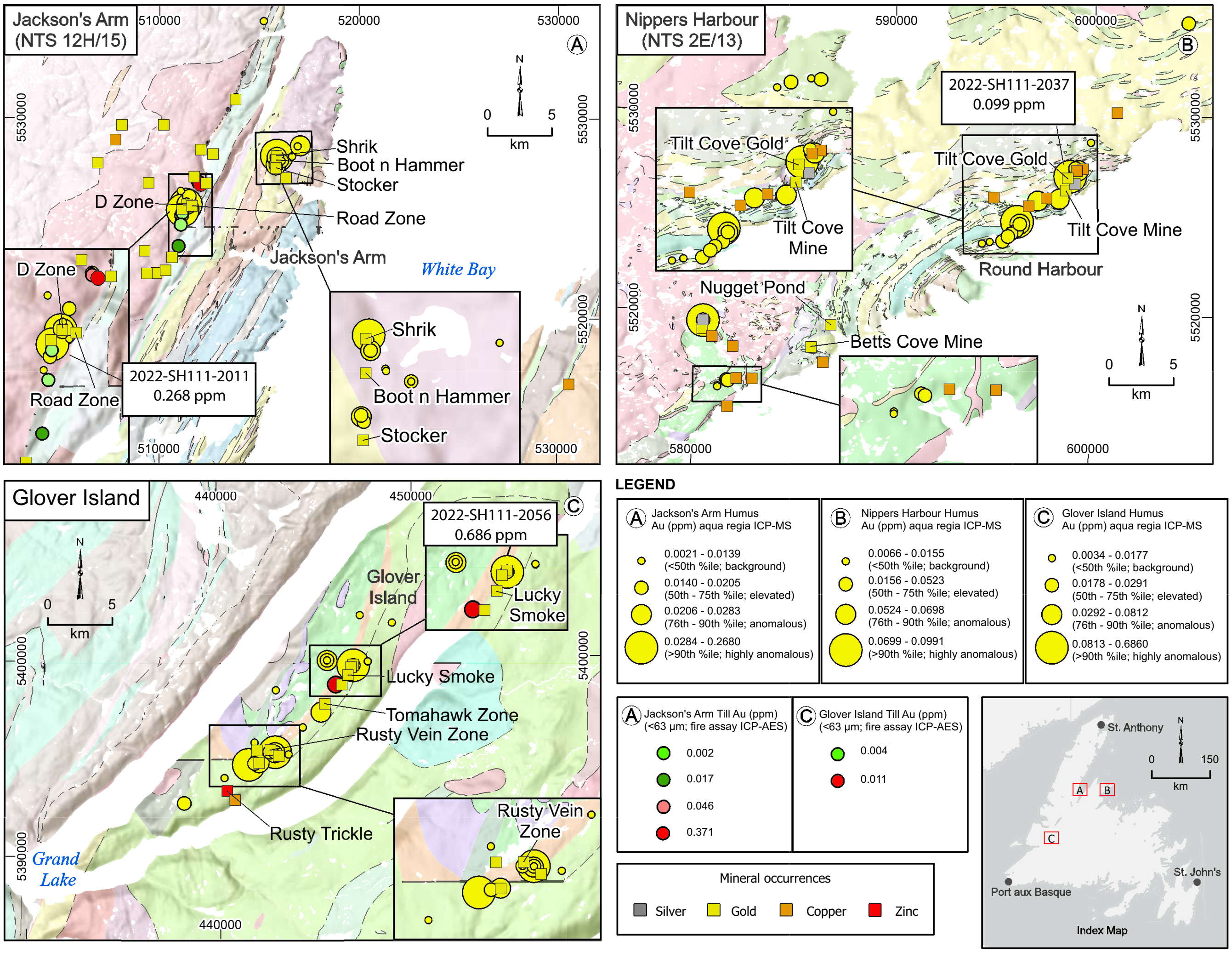


Figure 11. *Proportional dot plots for Au in humus samples analyzed by* aqua regia *ICP-MS and till samples.*

Zone and Shrik Au showings. Elevated to highly anomalous Pt and Pd content is present near Stocker and Boot n Hammer (up to 0.008 ppm Pt in 2022-SH111-2015 and 0.009 ppm Pd, both by *aqua regia*; Figures 15 and 16). Anomalous Pt (0.007 ppm) is also present in 2022-SH111-2001, collected approximately 400 m northeast of the D Zone Au showing and will be discussed in a later section.

Of the elements that strongly correlate with Au ($r^2 > 70$; determined by Spearman correlation matrix), elevated to highly anomalous element contents by *aqua regia* are present in humus samples collected near Shrik, Boot n Hammer and Stocker Au showings. These include Cu (up to 255 ppm), Ni (up to 161 ppm), Se (up to 28 ppm), Te (up to 0.63 ppm), Pb (up to 800 ppm) and Sb (up to 12.2 ppm) (Figures 17 and 18; Appendix F). The highest contents by Na pyrophosphate, including Cu (3.67 ppm), Se (up to 0.57 ppm), Te (up to 0.019 ppm) and Pb (up to 30.4 ppm) are present in humus samples collected near the D Zone and South Zone Au indications (Figure 19; Appendix G). The highest Zn (up to 2210 ppm by *aqua regia* and up to 72.4 ppm by Na pyrophosphate) is also present in humus samples collected near the D Zone and South Zone Au indication (Appendix F and G).

Note that anomalous Au, Ag, Se, Pb, elevated Pt, Cu, Ni, Te, Sb and Zn content is also present in humus samples collected northeast of Shrik, Stocker and Boot n Hammer Au showings. These samples are not near any other currently known Au showings and not down ice of Shrik, Boot n Hammer or Stocker Au showings. It is highly likely that the anomalous element content in these humus samples is associated with an unknown Au and/or Ag (?) occurrence and discussed in a later section (*see* "follow up for humus samples").

Nippers Harbour Map Area

In the Nippers Harbour map area, elevated to highly anomalous Au content is present in humus samples collected

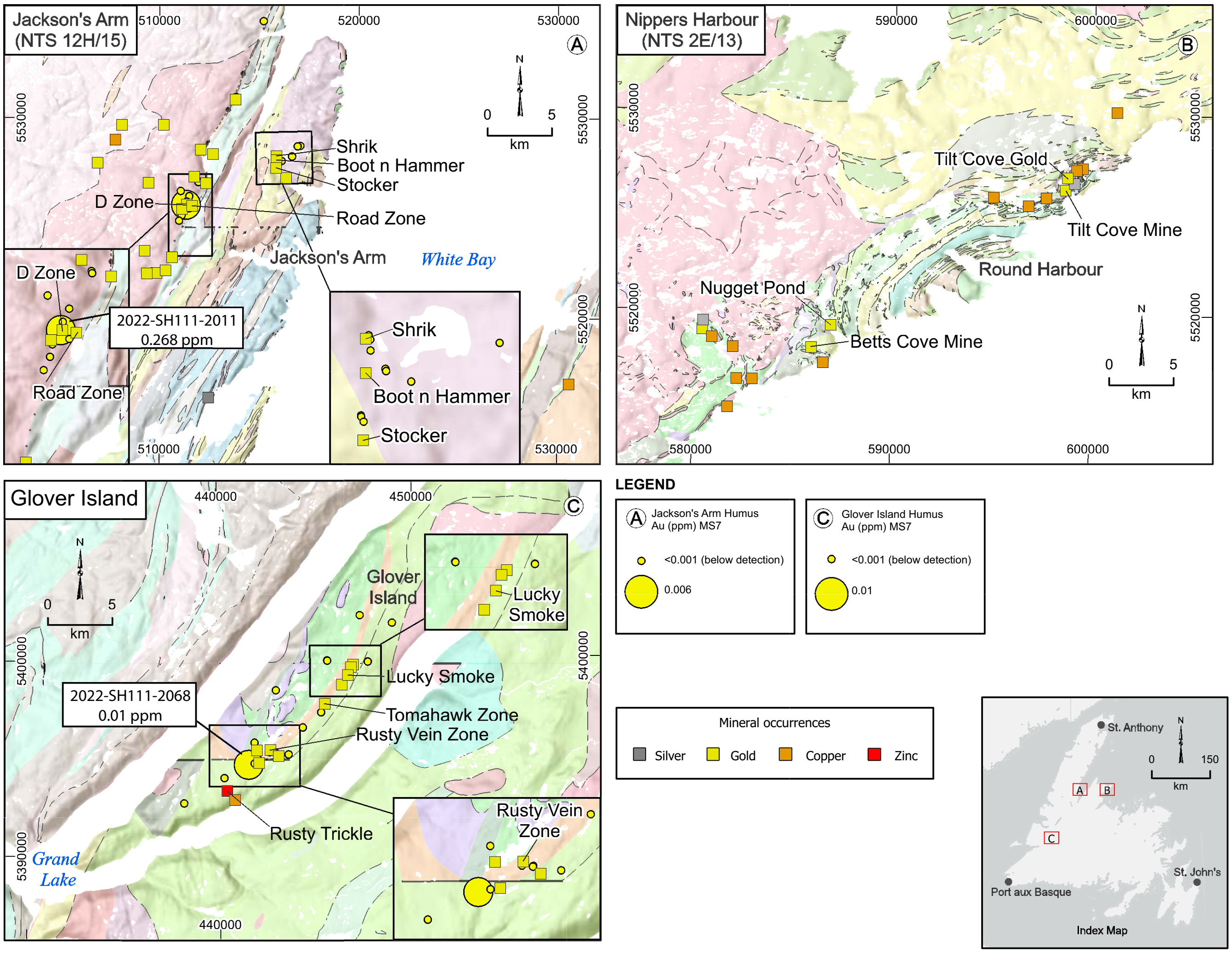


Figure 12. *Proportional dot plots for Au in humus samples analyzed by Na pyrophosphate ICP-MS.*

in the vicinity of Au occurrences including Scarp Zone Au prospect, Tilt Cove Cu showing, Round Harbour Road No 3 pyrite indication and Nippers Harbour North Au indication. Gold is not detected by Na pyrophosphate in the Nippers Harbour map area. Background Au content (*i.e.*, <50th %ile) ranges 0.007 to 0.016 ppm for *aqua regia*. The highest Au content (0.099 ppm by *aqua regia*) occurred in sample collected near the Tilt Cove Cu occurrence (Figure 11). Similarly, highly anomalous Ag (7.3 ppm) is present in 2022-SH111-2028 sample collected near Nippers Harbour Prospect 1 Cu prospect; the highest Ag (0.034 ppm) by Na pyrophosphate is present in 2022-SH111-2046, collected in the vicinity of Round Harbour Road No. 3 pyrite indication (Figures 13 and 14). Elevated to highly anomalous Pt (0.007 ppm) is present in 2022-SH111-2034 near Scarp Zone Au prospect, whereas up to 0.01 ppm Pd is present in 2022-SH111-2045, near Round Harbour Road No. 3 pyrite indication (Figures 15 and 16).

Of the elements that strongly correlate with Au, elevated to highly anomalous element contents are present in humus samples collected near Tilt Cove Cu showing. These include Cu (up to 1045 ppm by *aqua regia* and up to 25 ppm by Na pyrophosphate), Ni (up to 225 ppm by *aqua regia* and 3.73 by Na pyrophosphate), Te (up to 0.31 ppm by *aqua regia* and 0.008 ppm by Na pyrophosphate), Sb (up to 6.37 ppm by *aqua regia* and 0.046 by Na pyrophosphate; (Figures 17–20; Appendices G and F).

Glover Island

At Glover Island, elevated to highly anomalous Au concentration occur in humus samples collected near Au occurrences including Jacomar, Keystone and Discovery Vein Au showings, and are reflected by both analyses. The highest Au content (0.686 ppm by *aqua regia*) is present in 2022-SH111-2056, collected <50 m south of Jacomar (Figure 12). Only one sample (2022-SH111-2068) returned detectable Au by Na

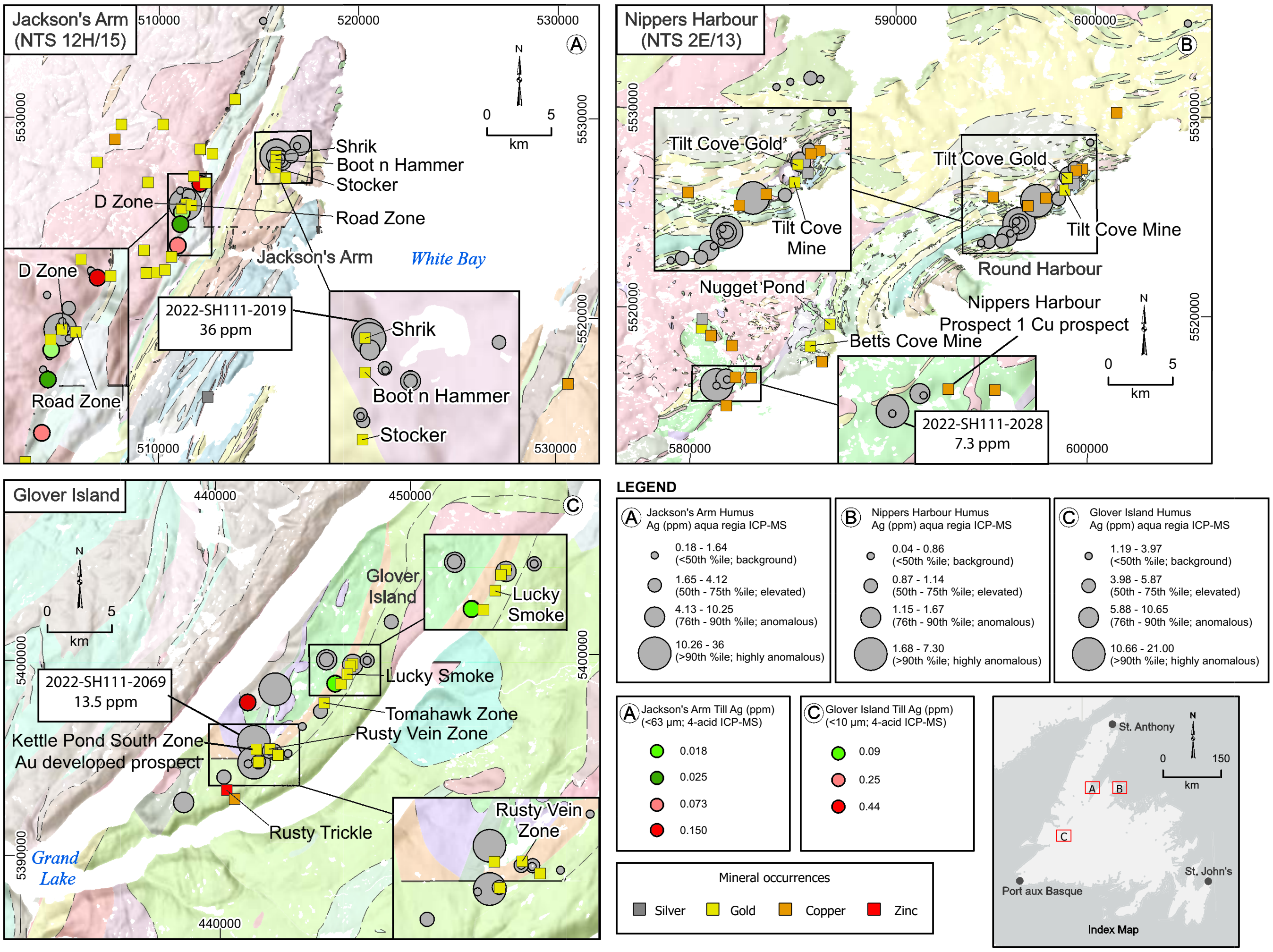


Figure 13. *Proportional dot plots for Ag in humus samples analyzed by* aqua regia *ICP-MS and till samples.*

pyrophosphate (0.010 ppm), collected <250 m west of Lunch Pond South Extension Au developed prospect (Figure 13). Similarly, elevated to highly anomalous Ag content, up to 14 ppm by *aqua regia* in 2022-SH111-2069 and 0.08 ppm by Na pyrophosphate in 2022-SH111-2068 (Figures 14 and 15) occur in samples collected near Kettle Pond South Zone Au and Lunch Pond Vein South Extension developed prospects, respectively. Highly anomalous Pt (up to 0.05 ppm) in 2022-SH111-2059FD and Pd (0.012 ppm) in 2022-SH111-2059FD contents are also present near Discovery Vein Au showing (Figures 16 and 17).

Of the elements that correlated well with Au, anomalous to highly anomalous element contents are present in humus samples collected near Lunch Pond South Extension Au developed prospect. These include Cu (up to 269 ppm by *aqua regia* and 5.1 ppm by Na pyrophosphate), Pb (up to 920 ppm by *aqua regia* and 17 ppm by Na pyrophosphate), and Zn (1335 ppm by *aqua regia* and 32 ppm by Na pyrophosphate) (Figures 17 and 9; Appendices F and G).

Elevated to highly anomalous Ni (up to 190 ppm in 2022-SH111-2059FD by *aqua regia* and 2.3 ppm in 2022-SH111-2060 by Na pyrophosphate; Figures 18 and 20), Se (up to 35 ppm by *aqua regia* and 0.4 ppm by Na pyrophosphate; Appendix F and G), Te (up to 0.16 ppm by *aqua regia* and 0.01 ppm by Na pyrophosphate; Appendix F), Sb (up to 15 ppm by *aqua regia* and 0.03 ppm by Na pyrophosphate; Appendices F and G) are present in humus samples collected near Discovery Vein Au showing.

TILL PARTICLE SIZE ANALYSIS AND GEOCHEMISTRY

Particle size analysis was completed on all 8 till samples. For this report, "clay" is defined as <10 µm because this size fraction is used for "clay-sized fraction" analyses at ALS. Overall, till samples collected on Glover Island had a higher silt + clay and the clay content compared to Jackson's Arm map area (Figure 21). This may explain the insufficient recovery of the <10 µm till fraction for analysis in the Jack-

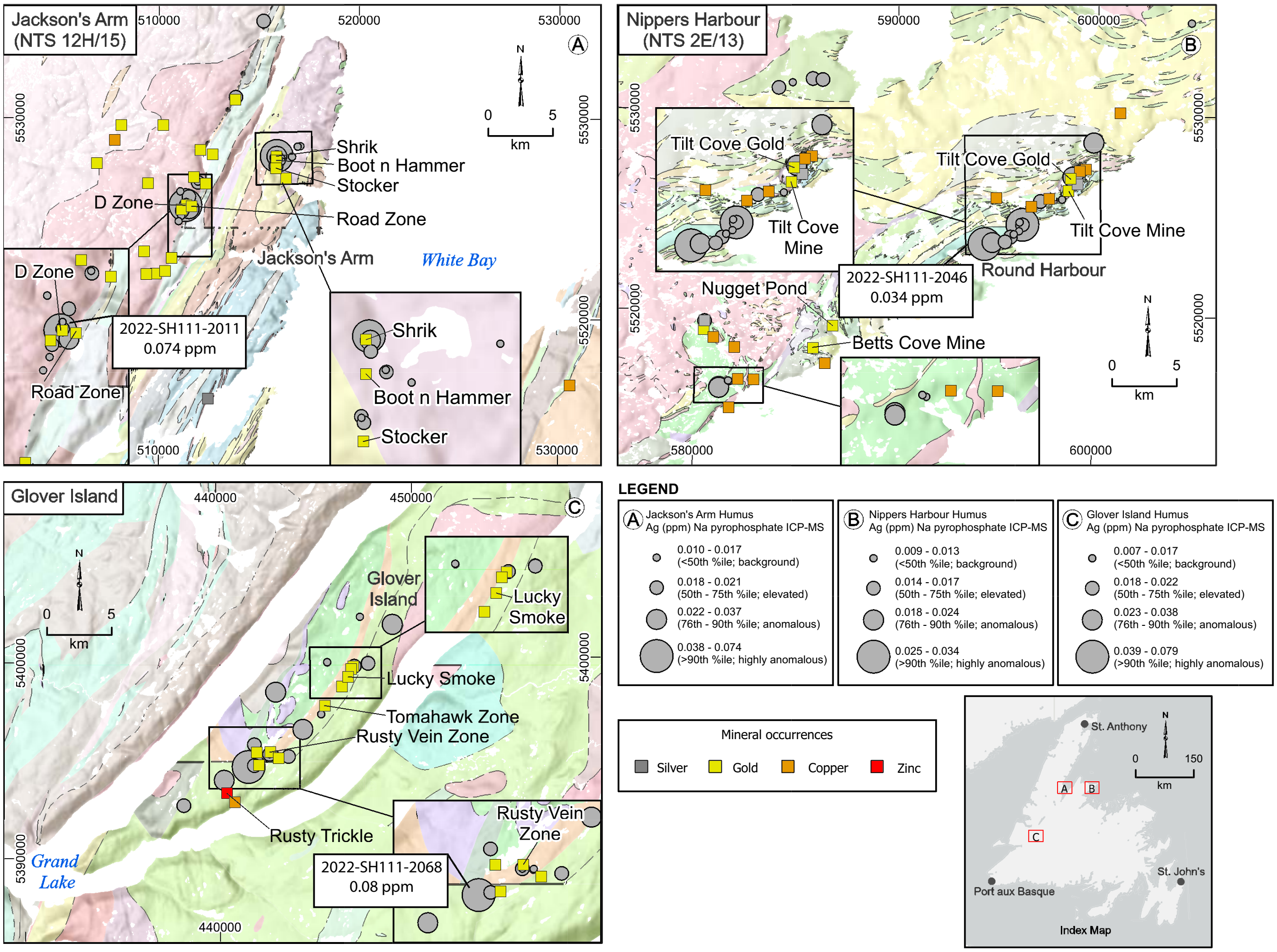


Figure 14. *Proportional dot plots for Ag in humus samples analyzed by Na pyrophosphate ICP-MS.*

son's Arm map area. The relative difference in the clay content between the two study sites reflects the bedrock sources of till. The till samples collected in the Jackson's Arm map area are derived from the felsic plutonic granitoid rocks of the Apsy Granite which produce a sand-rich till. The till on Glover Island is derived primarily from the volcanic marine and sedimentary rocks of the Glover Group, produce a silt-rich till.

Jackson's Arm Map Area

Five till samples were collected along the regional main road (Cat Arm Road) in the vicinity of North Fault, D Zone and South Zone Au showings (Figure 21). Two till samples (2022-SH111-1001 and 2022-SH111-1002) were collected immediately southeast, <500 m down-ice, of North Fault Au showing, two samples were collected <200 m (2022-SH111-1004) and <800 m (2022-SH111-1005) south, southwest of South Zone Au showing and one till sample (2022-SH111-1003) was collected northeast, 650 m down ice, of Beaver Dam Au showing. Here, geochemistry results are discussed for the <63µm till fraction as enough <10 µm fraction was recovered from only one till sample. These results are presented in Table 4 and Appendix B but not discussed in text. Also, only results for analytical technique that returned the highest element content are presented.

Gold content in the <63 µm till fraction, analyzed by fire assay returned the highest value. The two till samples collected <500 m down-ice of North Fault contained up to 0.371 ppm Au (2022-SH111-1002) and 0.05 ppm Au (2022-SH111-1001). A till sample collected down-ice of Beaver Dam Au showing returned 0.017 ppm Au, whereas till samples collected south, southeast of South Zone contained only 0.002 ppm Au and is considered background Au content. Similarly, up to 0.15 ppm Ag by *aqua regia* ICP-MS (0.17 ppm Ag in the <10 µm till fraction by *aqua regia* ICP-MS) is noted in the till sample that contained the highest Au content. Up to 0.073 ppm Ag is noted in till sample down ice of Beaver Dam Au showing.

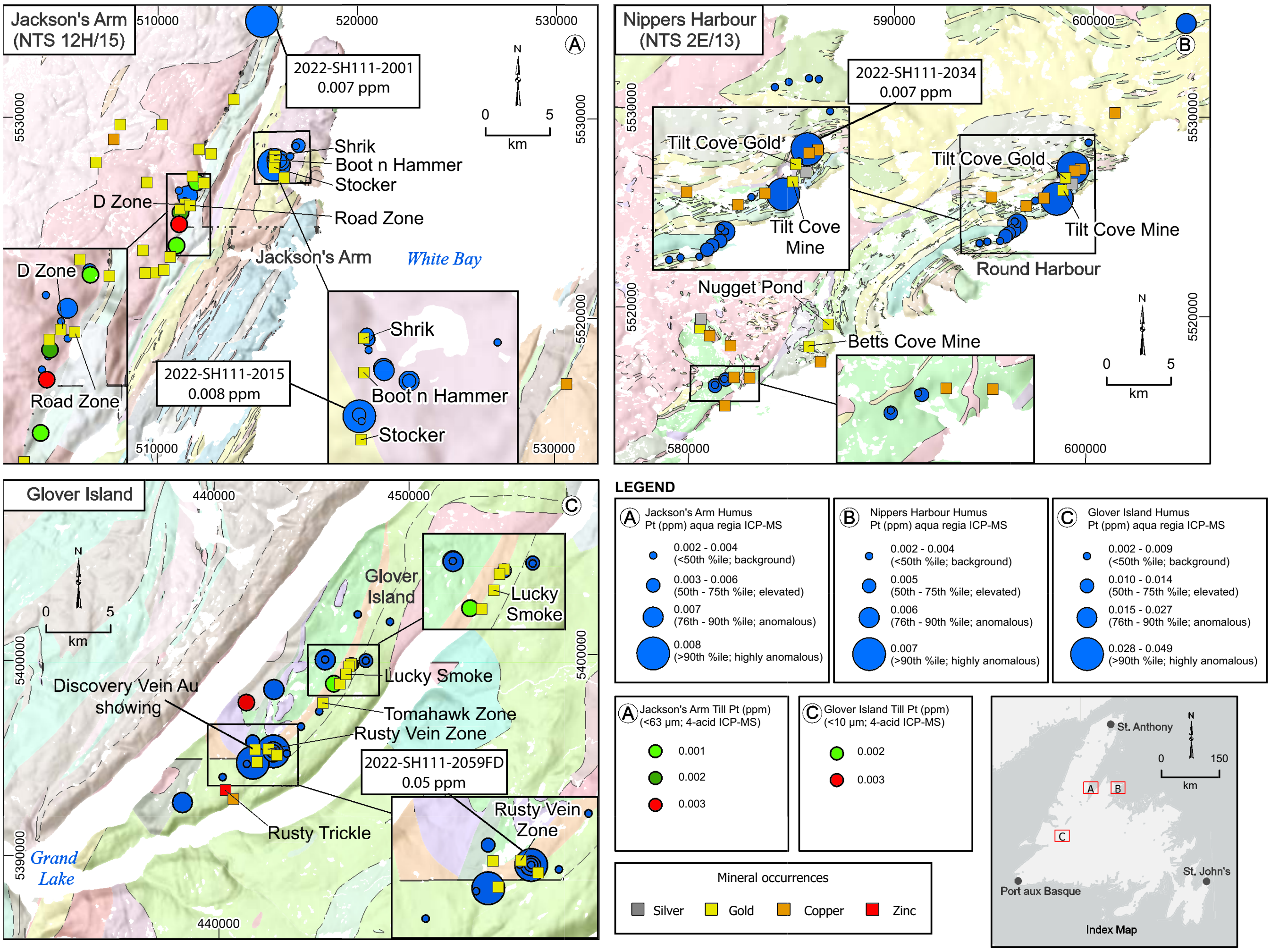


Figure 15. *Proportional dot plots for Cu in humus samples analyzed by* aqua regia *ICP-MS and till samples.*

Copper by *aqua regia* ICP-MS was noted in all till samples. The highest Cu content of 61 ppm is present in a till sample southeast of the South Zone, which contains background Au (2 ppb). Note that Cu in the <10 µm till fraction, analyzed by *aqua regia* ICP-MS returned a value of 233 ppm (2022-SH111-1003) which is significantly higher compared to its value (48 ppm) in the <63 µm till fraction. Platinum by *aqua regia* ICP-MS is present in three till samples; the highest Pt content (3 ppb) is noted in the till sample south, southeast of the South Zone that also contained the highest Cu content. Up to 36 ppm Ni (by 4-acid ICP-MS) is noted in the till sample down-ice of Beaver Dam Au showing.

Of the conventional associated elements for Au, up to 0.249 ppm Sb by *aqua regia* ICP-MS was present in the <63 µm till fraction of sample (2022-SH111-1003) down ice of the Beaver Dam Au showing, whereas up to 0.19 ppm Sb was present in till sample down-ice of North Fault Au showing. Both samples also contained high Au content. Similarly, up to 390 ppm As is present in till sample down ice of North Fault Au showing. The second highest content of 62 ppm is recovered from the till sample down ice of Beaver Dam Au showing This <10 µm till fraction of this sample (2022-SH111-1003) returned 213 ppm As. Up to 0.101 ppm Bi (in <63 µm till fraction analyzed by 4-acid ICP-MS) and 0.230 ppm Bi (in the <10 µm till fraction analyzed by *aqua regia* ICP-MS) is present in a till sampled collected down-ice of Beaver Dam Au showing. Up to 0.032 ppm Bi is noted in till sample down ice of North Fault Au showing.

Overall, the till samples collected down ice of known Au occurrences in the Jackson's Arm map area have elevated concentrations of Au, Ag and Pt. Although the <10 µm till fraction was only analyzed for one till sample (2022-SH111-1003), the trace-element content in the <10 µm till fraction was at least ten times higher than the trace-element content in the <63 µm till fraction for the same sample.

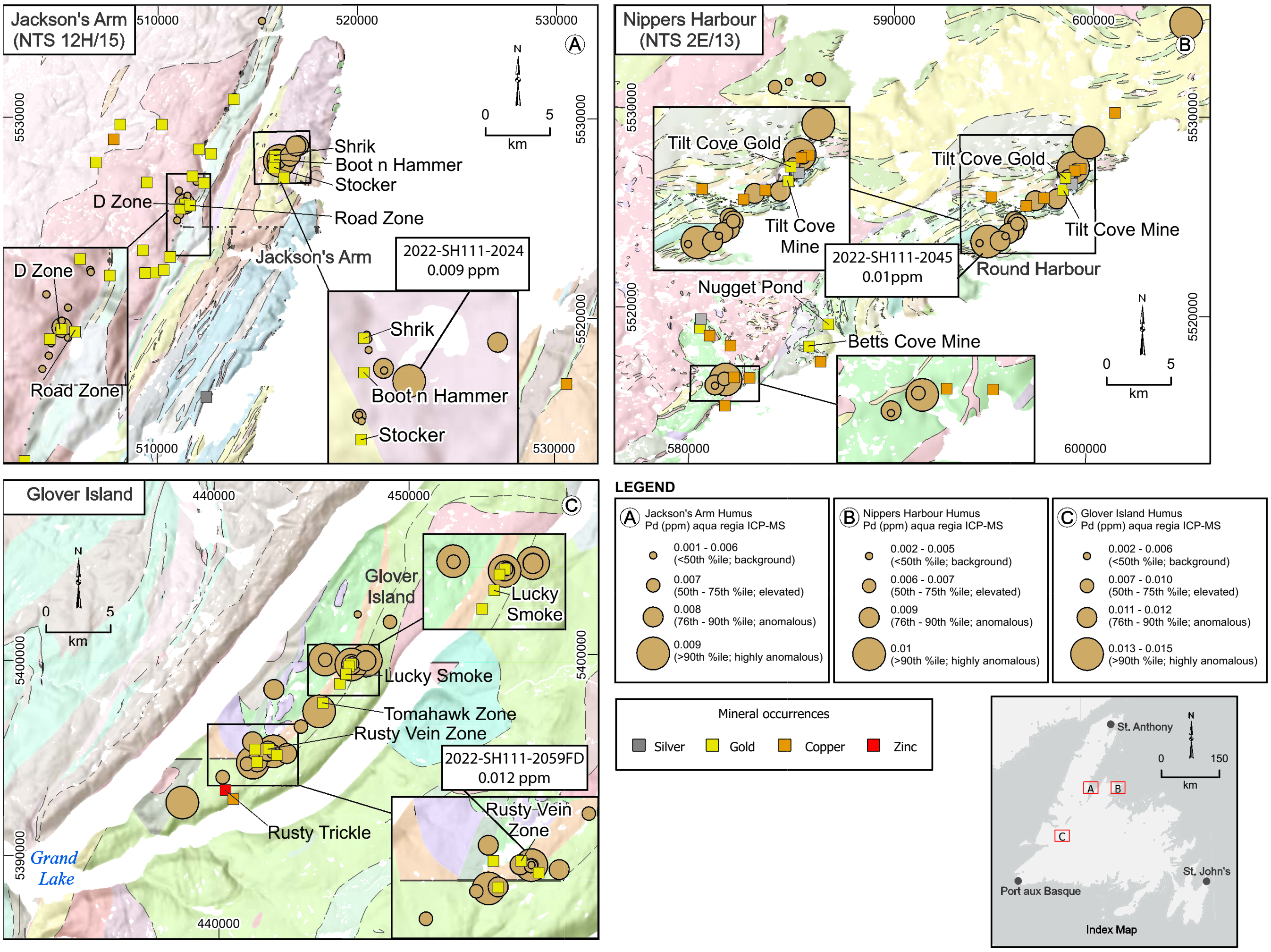


Figure 16. *Proportional dot plots for Cu in humus samples analyzed by Na pyrophosphate ICP-MS.*

Glover Island

Three till samples were collected on Glover Island. Two samples were collected approximately 300 m west (down ice) of Tomahawk Zone Au showing, whereas one till sample was collected over siliciclastic marine sandstone of the Fleur de Lys Supergroup. The geochemistry results for the <10 µm till fraction will be presented here as this size fraction was analyzed for all three samples and these returned the highest element content (except Au and Pt).

Overall, Au content in the <63 µm till fraction, analyzed by fire assay returned the highest content. 0.011 ppm Au is present in till sample collected immediately down ice of the Tomahawk Zone Au showing; however, the second down-ice sample contained background Au content. Up to 0.004 ppm Au is present in till sample collected over rocks of the Fleur De Lys Supergroup. The till samples down ice of Tomahawk also contained up to 0.25 ppm Ag. The highest Ag content (0.44 ppm; higher than in till samples from the Jackson's Arm map area) is present in the till sample collected over the Fleur De Lys Supergroup. Platinum is present in all three till samples; up to 0.003 ppm Pt is present in the <63 µm till fraction, analyzed by *aqua regia* ICP-MS is present in a till sample down ice of Tomahawk as well as in the till sample collected over the Fleur De Lys Supergroup. Up to 0.003 ppm Pt is present in a till sample down ice of Tomahawk as well as in the till sample overlying the Fleur De Lys Supergroup.

Of the associated elements, the highest contents for Te (0.19 ppm), Sb (3.21 ppm), Zn (130 ppm), Pb (67 ppm) and Sn (12 ppm) are present in till sample (2022-SH111-1006) down-ice of the Tomahawk Zone Au showing. The highest contents for Cu (178 ppm), Ni (258 ppm), Se (5 ppm), Mo (3.3 ppm), Cd (0.97 ppm), Co (67 ppm) and As (129 ppm) are present in till sample (2022-SH111-1008) collected over the Fleur De Lys Supergroup. There are no known Au (or

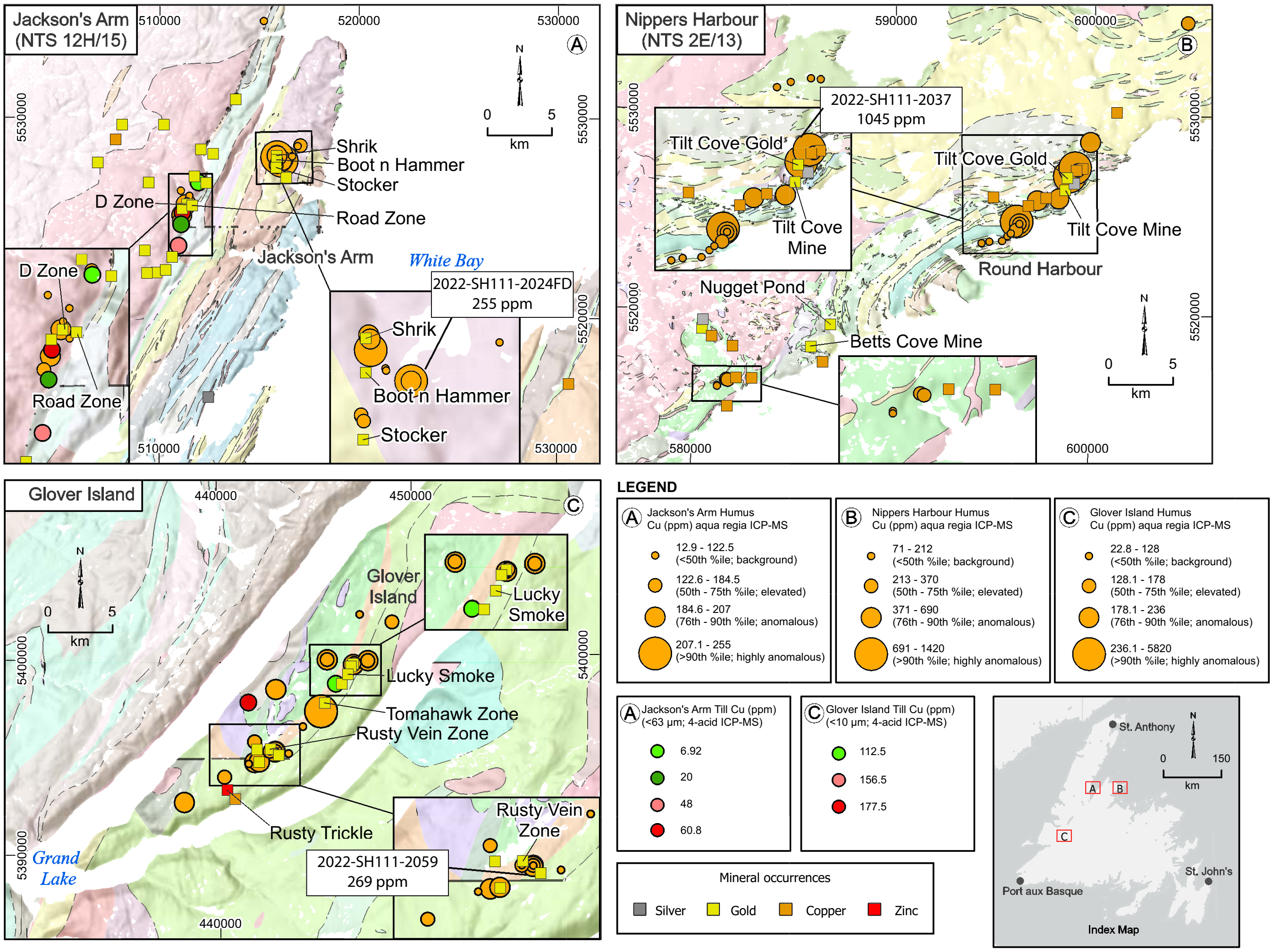


Figure 17. *Proportional dot plots for Ni in humus samples analyzed by* aqua regia *ICP-MS and till samples.*

other) occurrences in the immediate vicinity. This sample site warrants follow up till sampling, including detailed pebble lithological analysis to determine lithologic provenance.

PARENT MATERIAL INFLUENCE ON HUMUS GEOCHEMISTRY

Due to the paucity of unweathered, C-horizon till, only eight till samples were collected in the Jackson's Arm map area and Glover Island. However, a thin (<0.2 m) till veneer was noted at most humus sampling sites, characterized by weathered, silty sand and pebbly to cobbly gravel-sized clasts. In the Jackson's Arm map area and Glover Island, the geochemical signature of humus reflects, in part, the underlying bedrock and also the glacial dispersal of metal-rich till (*i.e.*, underlying till). For example, in the Jackson's Arm map area, the ice-flow direction is to the east–northeast and east–southeast. Elevated to anomalous ore and associated element contents are noted in humus samples collected down-ice of Shrik and Boot n Hammer Au showings. Samples 2022-SH111-2019 and 2022-SH111-2020 are down ice of Shrik Au showing and contain elevated to highly anomalous contents of Ag (up to 36 ppm), Au (0.011 ppm), Bi (3.3 ppm), Cd (13.2 ppm), Cu (207 ppm), Hg (0.01 ppm), In (0.17 ppm), Mo (8 ppm), Ni (59 ppm), Pb (566 ppm), Pt (0.006 ppm), S (3.2 ppm), Sb (12 ppm), Se (20 ppm), Sn (35 ppm), Te (0.63 ppm) and Zn (1480 ppm) as determined by *aqua regia*. Similarly, samples 2022-SH111-2022 and 2022-SH111-2023 are <120 m down ice of Boot n Hammer Au showing and contain elevated to highly anomalous contents of Ag (3 ppm), As (22 ppm), Bi (5.3 ppm), Hg (0.001 ppm), In (0.25 ppm), Mo (8.2 ppm), Ni (50 ppm), Pb (699 ppm), Pd (0.007 ppm), Pt (0.007 ppm), S (3 ppm), Sb (12 ppm), Se (26 ppm), Sn (32 ppm), Te (0.39 ppm) and Zn (1145 ppm) as determined by *aqua regia*.

At Glover Island, the ice-flow direction is to the west–northwest. Elevated to highly anomalous ore and associated element contents are noted in humus samples collected northwest (down-ice) of the Kettle Pond South Zone Au showing.

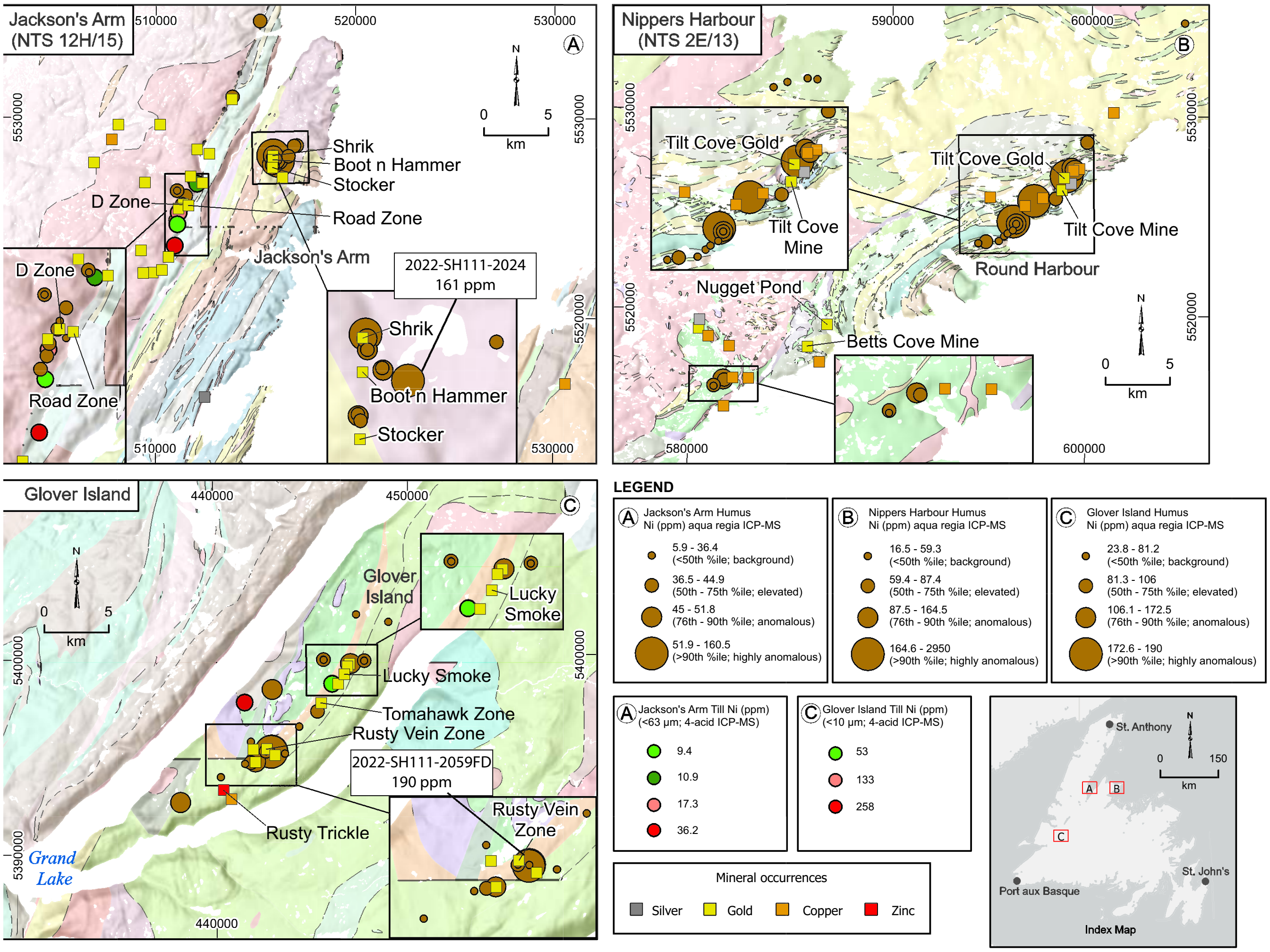


Figure 18. *Proportional dot plots for Ni in humus samples analyzed by Na pyrophosphate ICP-MS and till samples.*

Sample 2022-SH111-2069 is approximately 400 m down-ice and contains anomalous contents of Ag (up to 14 ppm), Pb (753 ppm), elevated Bi (2.7 ppm), Co (19 ppm), Cd (8 ppm), Cu (127 ppm), Hg (0.002 ppm), Mo (5 ppm), Pd (0.008 ppm), Pt (0.013 ppm), S (2 ppm), Sb (9 ppm), Sn (15.1 ppm) and Zn (725 ppm) determined by *aqua regia*. Humus sample 2022-SH111-2070 is <300 m down-ice of Glover Island South Silver Ag showing and contains elevated contents of Ag (5 ppm), Co (26 ppm), Cd (9 ppm), Cu (73 ppm), Pb (548 ppm), Sn (12 ppm), Zn (448 ppm) and anomalous Hg (0.007 ppm) by *aqua regia*.

COMPARISON OF HUMUS GEOCHEMISTRY TO OTHER STUDIES

Several studies on the suitability of humus as a sample medium for grassroots Au, Ni–Cu–PGE and base-metal exploration have previously been carried out in Canada in the eighties and nineties (Table 1). These include humus sampling in the vicinity of Au-bearing pyrite in Thunder Bay district (northern Ontario) by Fortescue (1985). The author reported up to 75 ppb Au in humus samples collected in the vicinity of Au mineralization. Similarly, McClenaghan *et al.* (1995) carried out an extensive study in the Timmins region, whereby the authors reported highly anomalous Au (up to 443 ppb), Ag (up to 666 ppb) and (up to 586 ppm) Cu in the vicinity of Cu–Zn–Au–Ag mineralization in the area (McClenaghan *et al.*, 1996). Another study by Dunn (1998) in the La Ronge area (Saskatchewan) reported up to 174 ppb Au and 1300 ppb Ag in humus samples the vicinity of Au and Cu mineralization. Further, the Flin Flon region in Manitoba hosts Cu–Zn–Au–Ag mineralization. Here, McMartin *et al.* (1996) reported high Ag (up to 7600 ppb), Cu (3820 ppm) in the vicinity of Cu–Zn–Au–Ag mineralization. Similarly, Bajc and Hall (2000) carried out a humus sampling study in the North and East Ranges of the Sudbury basin and reported high Au (up to 85 ppb), Ag (up to 2200 ppb), Pt (121 ppb), Pd (118 ppb) in humus samples collected the vicinity of Ni–Cu–PGE mineralization. A more recent follow up study by Hashmi (2018) and Hashmi *et al.* (2022) in

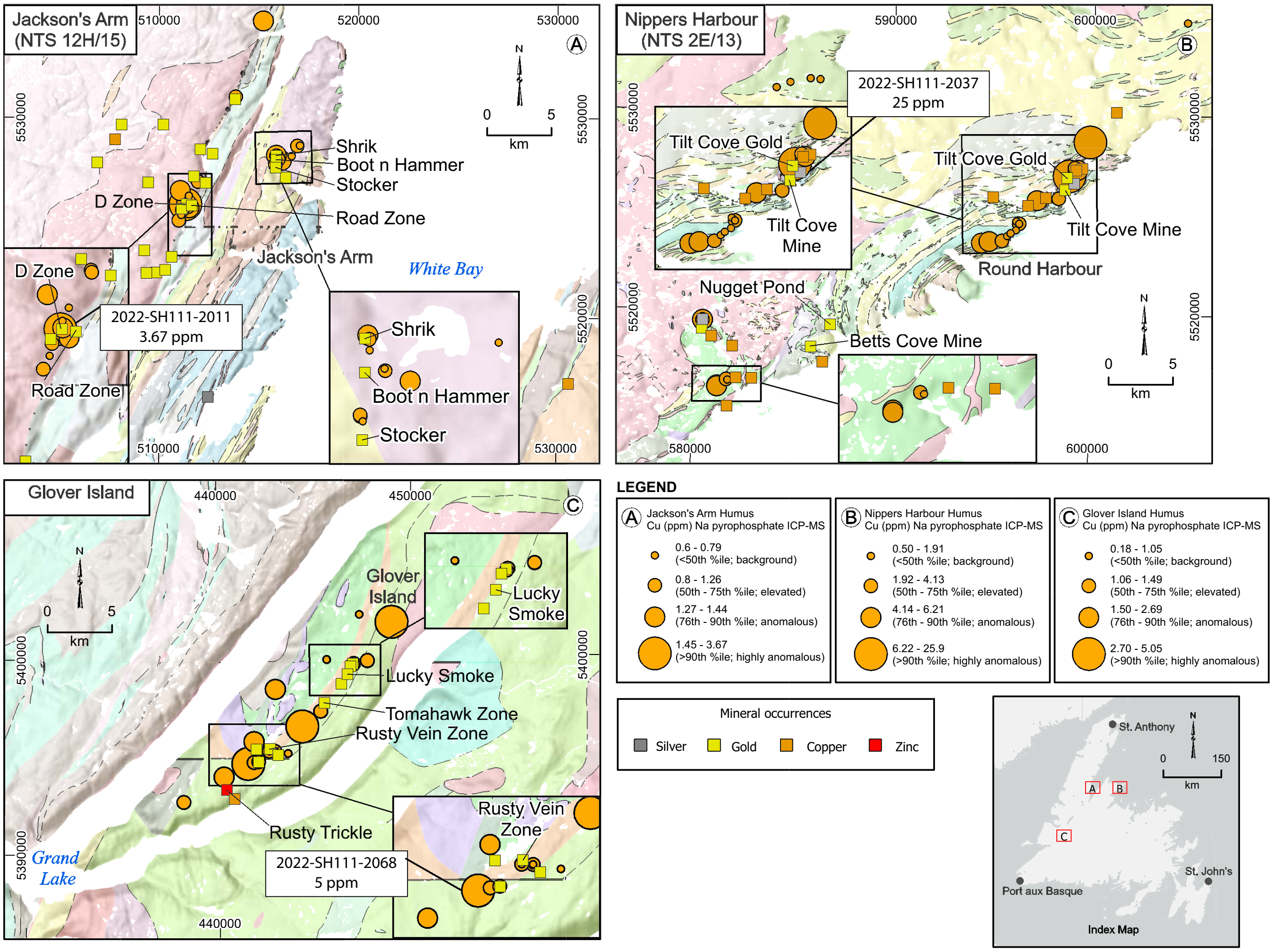


Figure 19. *Proportional dot plots for Pt in humus samples analyzed by* aqua regia *ICP-MS and till samples.*

the Sudbury basin also reported high Au (294 ppb), Pt (53 ppb), Ni (433) and Cu (569 ppb) in the vicinity of Ni–Cu–PGE mineralization in humus samples in the South Range of the Sudbury basin.

The geochemical signature of humus near Au mineralization in this study is comparable to the results generated by previous studies around Au, Ni–Cu–PGE and base-metal mineralization. The highest Au and Ag content in humus samples was recovered in this study suggesting that humus is a viable sampling medium for Au (and associated Ag) mineralization.

RECOMMENDATIONS

FOLLOW UP FOR HUMUS SAMPLES

Although humus sampling focused on known Au occurrences and sampling sites that were considered "background samples", some sites have elevated to highly anomalous Au and associated element concentrations that form "clusters" (Figures 22, 23 and 24). These sample sites are not associated with known mineralization and warrant further investigation and are described below.

Jackson's Arm Map Area

Two areas with one or more humus samples containing elevated to highly anomalous Au and associated element concentrations are delineated in the Jackson's Arm map area (Figure 22).

1) Three humus samples collected northeast of Shrik, Boot n Hammer and Stocker have elevated Cu, Sn, Mo, elevated to anomalous Hg, In, Pb, Sb and anomalous Te, Se, Ni, and Cu (analyzed by Na pyrophosphate ICP-MS). These samples also have elevated Ag, Cr, Cu, Hg, Ni, Pt, S, Sb, Te, and Zn, anomalous concentrations of Ag, As, Au, Bi, Cd, In, Mo, Pb, Pd, Se and Sn, and highly anomalous concentrations of Bi and S (analyzed by *aqua regia* ICP-MS).

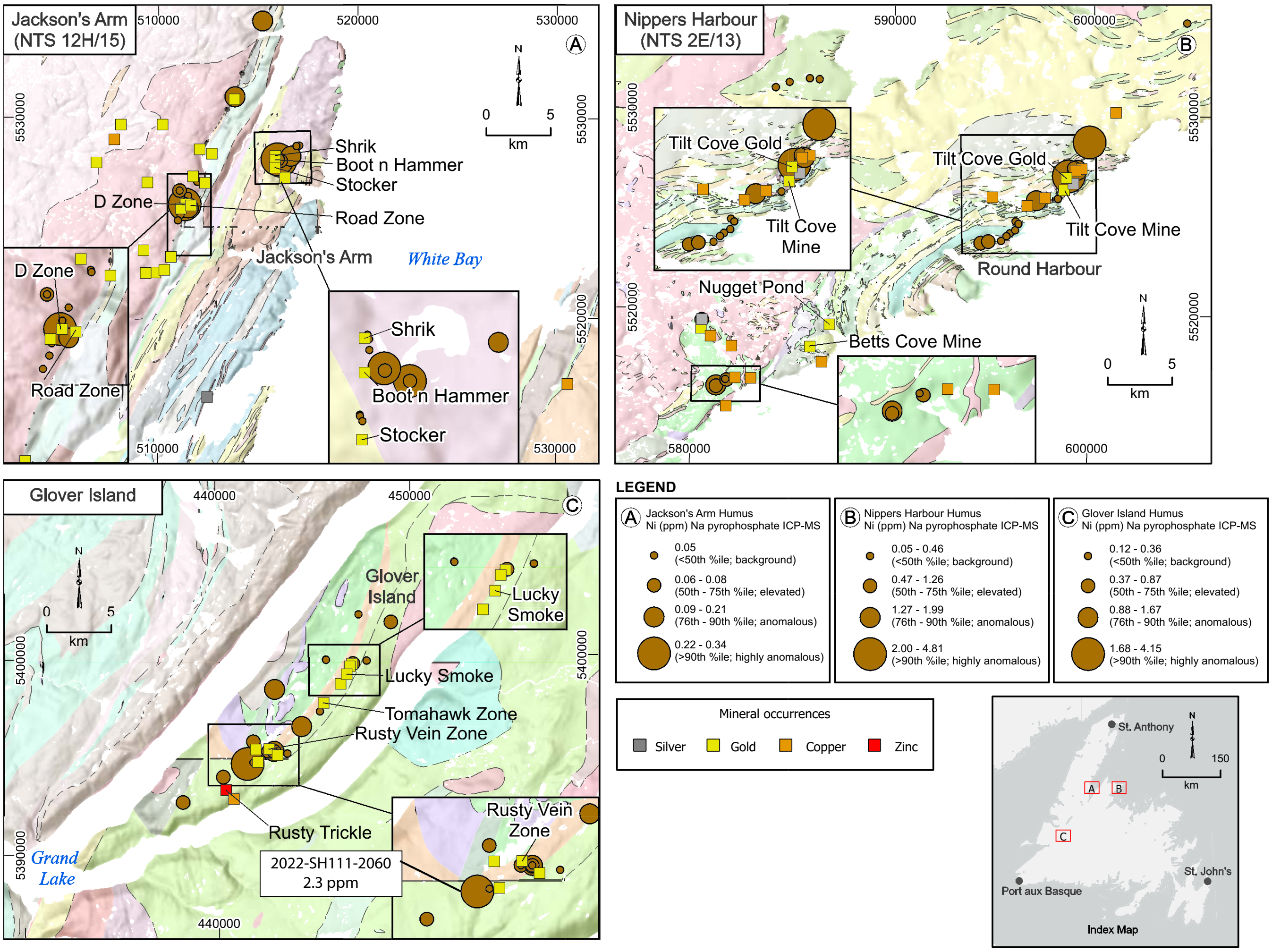


Figure 20. *Proportional dot plots for Pd in humus samples analyzed by* aqua regia *ICP-MS.*

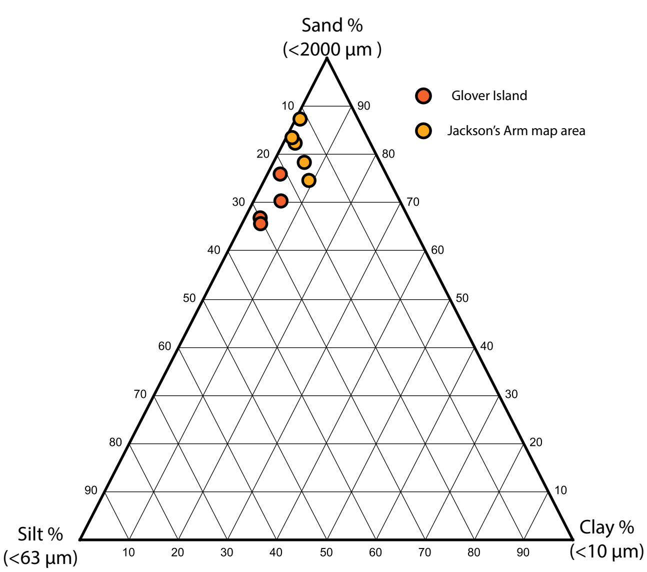


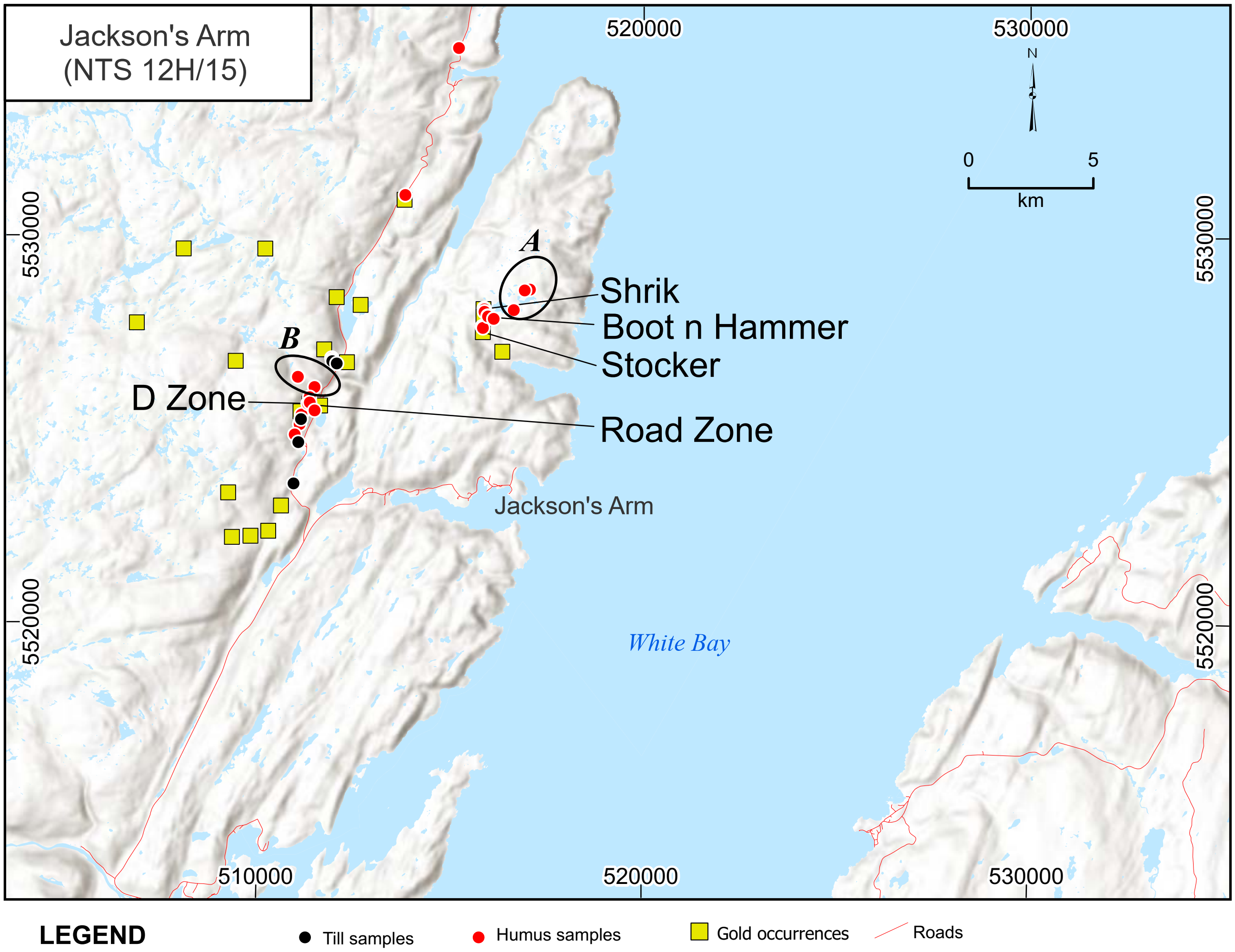
Figure 21. *Ternary diagram showing grain size distribution of the C-horizon till matrix.*

2) Two humus samples collected northwest of D Zone have elevated Zn, Sn, Ni, Hg, Cr, Cd, Co, Bi, anomalous Sb, Pb, Mo, In and Cu and highly anomalous Se (analyzed by Na pyrophosphate ICP-MS). These samples also have elevated Bi, Co, Cd, In, Mo, Ni, Pb, S and Sn by *aqua regia* ICP-MS.

Glover Island

Four areas with one or more humus samples on Glover Island contain elevated to highly anomalous Au and associated element concentrations (Figure 23).

1) Elevated Cd, Cr, Hg, In, Mo, Sb and Sn, anomalous Ag, Cd, Cu, Ni and Pb, and highly anomalous Co and Zn occur in a humus sample collected in west-central Glover Island (analyzed by Na pyrophosphate ICP-MS). This sample also contains elevated As, Bi, Cd, Mo, S, Sb, Sn and Te, anomalous Cu, Hg, Ni, Pb, Pd and Pt, and highly anomalous Ag, Co, Cr and Zn (analyzed by *aqua regia* ICP-MS).



A

Samples: 2022-SH111-2017, 2022-SH111-2018, 2022-SH111-2025
Humus samples analyzed by Na pyrophosphate ICP-MS
Elevated: Cu + Sn + Mo
Elevated to anomalous: Hg + In + Pb + Sb
Anomalous: Te + Se + Ni + Cu
Humus samples analyzed by aqua regia ICP-MS
Elevated: Ag + Cr + Cu + Hg + Ni + Pt + S + Sb + Te +Zn
Anomalous: Ag + As + Au + Bi + Cd + In + Mo + Pb + Pd + Se +Sn
Highly anomalous: Bi + S

B

Samples: 2022-SH111-2005, 2022-SH111-2005FD, 2022-SH111-2006
Humus samples analyzed by Na pyrophosphate ICP-MS
Elevated: Zn + Sn + Ni + Hg + Cr + Cd + Co + Bi
Anomalous: Sb, + Pb + Mo + In +Cu
Highly anomalous: Se
Humus samples analyzed by aqua regia ICP-MS
Elevated: Bi + Co + Cd + In + Mo + Ni + Pb + S + Sn

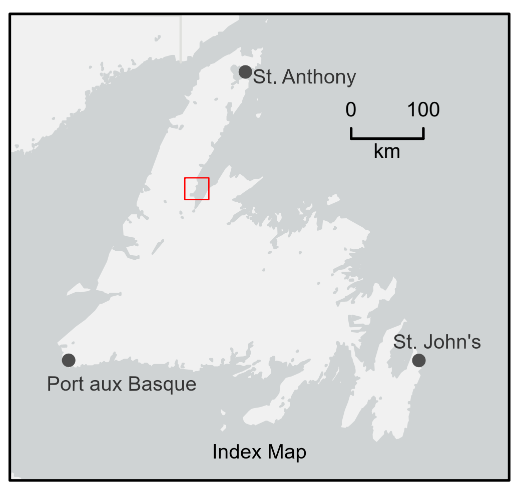


Figure 22. *Geochemical anomalies in humus samples analyzed by both* aqua regia *ICP-MS and Na pyrophosphate ICP-MS in the Jackson's Arm map area (NTS 12H/15) that are not associated with known mineral occurrences.*

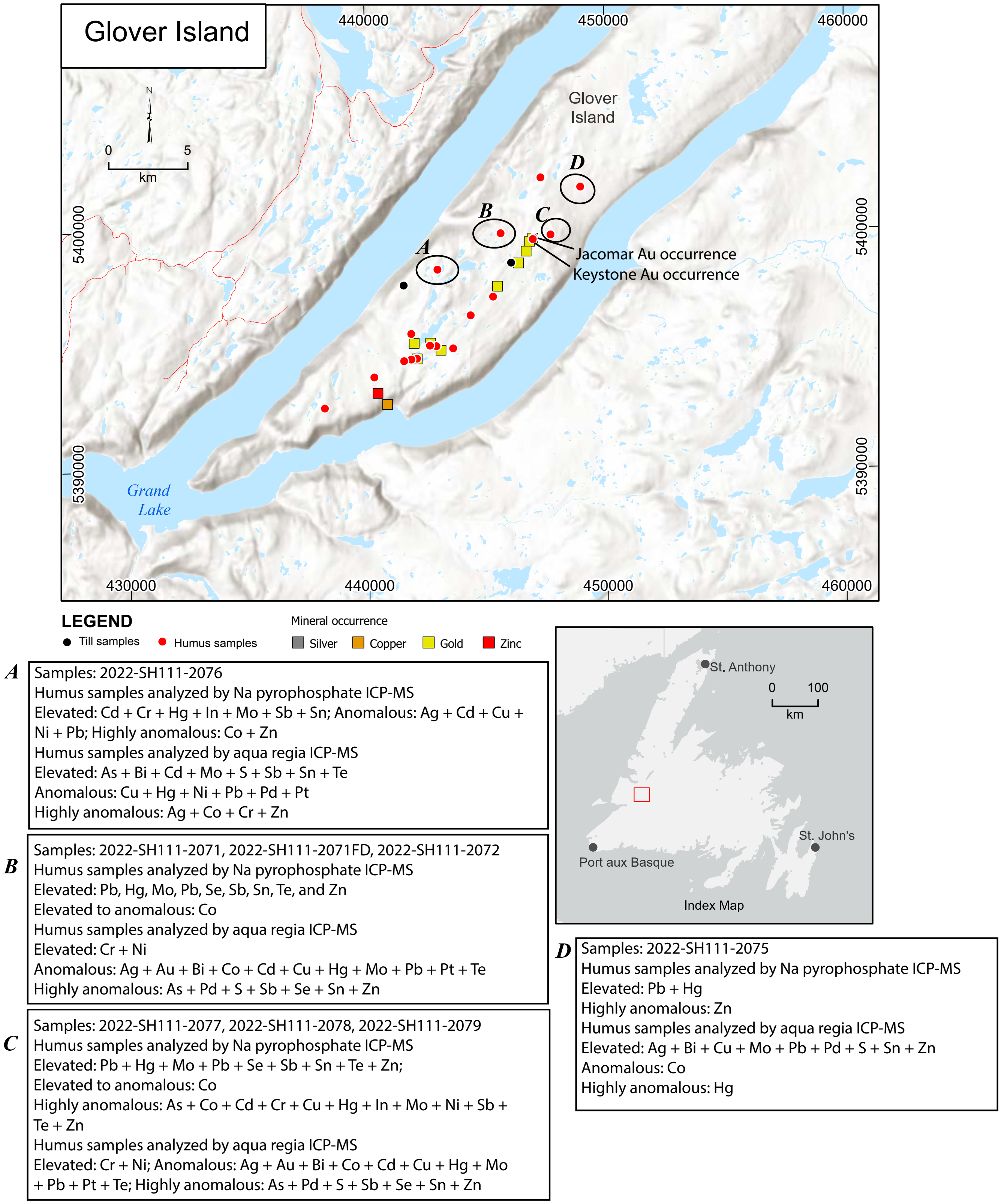


Figure 23. *Geochemical anomalies in humus samples analyzed by both* aqua regia *ICP-MS and Na pyrophosphate ICP-MS on Glover Island that are not associated with known mineral occurrences.*

2) Elevated Pb, Hg, Mo, Pb, Se, Sb, Sn, Te and Zn, and elevated to anomalous Co are present in a three humus samples collected >1 km west, northwest of Keystone Au occurrence (analyzed by Na pyrophosphate ICP-MS). These samples also contain elevated Cr and Ni, anomalous Ag, Au, Bi, Co, Cd, Cu, Hg, Mo, Pb, Pt and Te, and highly anomalous As, Pd, S, Sb, Se, Sn and Zn (analyzed by *aqua regia* ICP-MS).

3) Elevated Ag, As, Bi, Cu and Mo, anomalous Hg, In, Sb, Se, Sn and Te, and highly anomalous Co, Cd, Pb and Zn occur in three humus samples collected less than a kilometre, east, northeast of Jacomar Au occurrence. These samples also contain elevated Ag, Cr, Ni, Pt, Se, Te and Zn, anomalous As, Cu, Hg, Mo, S and Sb, and highly anomalous Bi, Co, Cd, Pb, Pd and Sn.

4) Elevated Pb and Hg and highly anomalous Zn is present in a humus sample collected up to 1.5 km northeast of Glover Island Zn occurrence. This sample also contains elevated Ag, Bi, Cu, Mo, Pb, Pd, S, Sn and Zn, anomalous Co and highly anomalous Hg (analyzed by *aqua regia* ICP-MS).

Note that of the three till samples collected on Glover Island, sample 2022-SH111-1008, collected less than 2 km north, northeast of Kettle Pond Brook Au occurrence contained the highest ore and associated element contents: up to 0.44 ppm Ag, and 0.003 ppm Pt and up to 129 ppm As, 67 ppm Co, 178 ppm Cu, 0.213 ppm Hg, 258 ppm Ni, 0.052% S and 5 ppm Se. This sample was collected as a background sample and is not near any known occurrences.

Nippers Harbour Map Area

Three areas with one or more humus samples containing elevated to highly anomalous Au and associated element concentrations are delineated in the Nippers Harbour map area (Figure 24).

1) Four humus samples collected along a trail, off Highway 414 contain elevated Ag, As, Cd, In, Pb and Sb concentrations, and anomalous Hg, Sn, Mo, Se, An, Te and Zn concentrations (analyzed by Na pyrophosphate ICP-MS). These samples also contain elevated Ag, Au, Bi, In, Pb, Pd, Sb and Sn, and anomalous As, Hg, Mo, Au, S and Te (analyzed by *aqua regia* ICP-MS).

2) One humus sample collected less than 1.5 km northeast of Mud Pond Au occurrence contained anomalous Ag, Bi, Se and Sn concentrations and highly anomalous As, Co, Cd, Cr, Cu, Hg, In, Mo, Ni, Sb, Te and Zn concentrations (analyzed by Na pyrophosphate ICP-MS). This sample also contains elevated As, Cd, Mo, Ni, Au, S and Te, anomalous Cu and Cr and highly anomalous Co, In and Pd (analyzed by *aqua regia* ICP-MS).

3) A cluster of 10 samples, collected northwest, north and northeast of Round Harbour contained elevated to highly anomalous Ag, Hg, Mo, Sn, Te and Zn, elevated to anomalous As, Bi, Cd, Cu, Pb, Sb and Se, anomalous Co, and elevated Cr, In, and Ni (analyzed by Na pyrophosphate ICP-MS). These samples also contained elevated to highly anomalous Ag, As, Au, Bi, Cu, Hg, In, Mo, Ni, Pb, S, Sb, Se, Sn and Zn, elevated Co, Cr, elevated to anomalous Cd, Pd, Pt and Te and highly anomalous Ag (analyzed by *aqua regia* ICP-MS).

OPTIMIZING HUMUS SAMPLING PROGRAMS: BEST PRACTICES AND RECOMMENDATIONS

Overall, the results of this study show that humus is an effective sampling medium for large-scale, greenfields exploration sampling targeting Au in Newfoundland in areas where till is too thin or not available because:

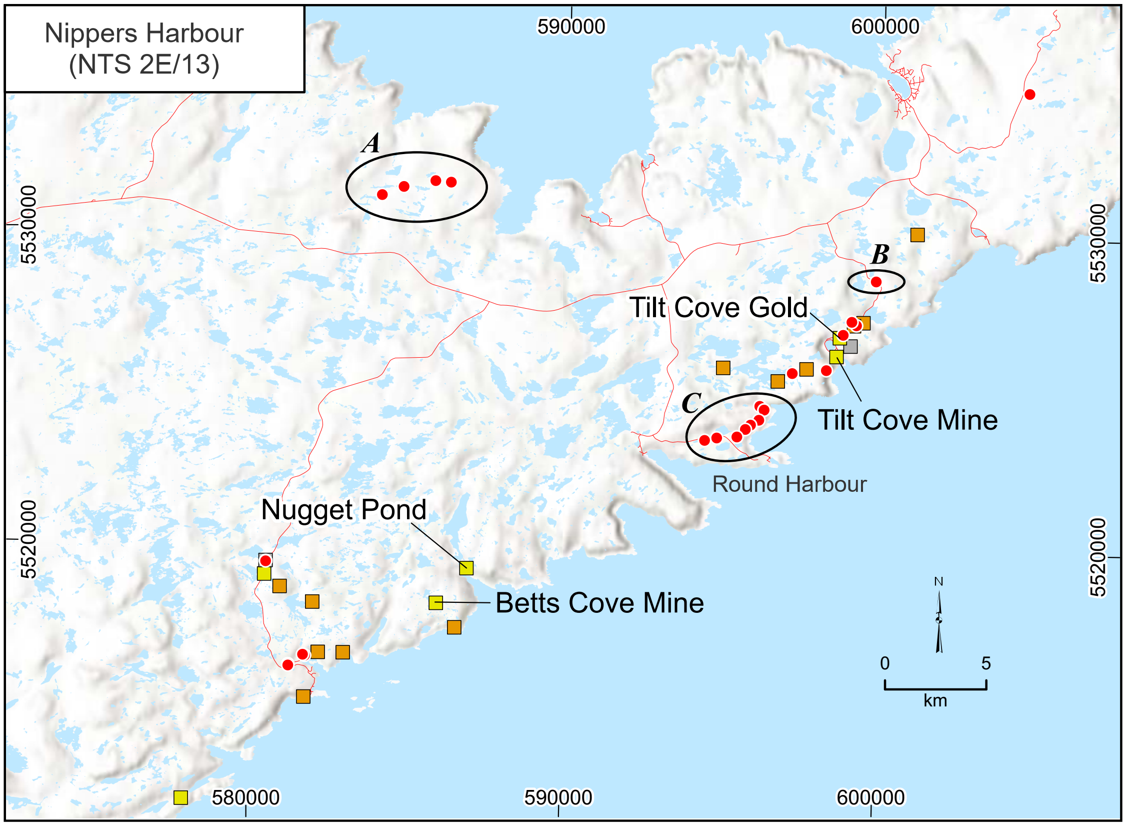
1) Humus is abundant, light weight, quick and easy to sample and analyze. Because it is ubiquitous and light weight, sampling crews can collect many samples relatively quickly (compared to till sampling) and easily, thereby covering a large region.

2) The cost per analysis is low. Each sample costs less than C$100 (2022 prices for ALS Geochemistry) at a commercial laboratory from preparation to analysis that includes sample drying, milling, ashing, *aqua regia* digestion ICP-MS for ultra-trace Au detection.

3) The data generated from this sampling program is high quality and includes ppt concentrations of Au, and ppb levels of other noble metals such as Ag, Pd and Pt.

4) Although Na pyrophosphate ICP-MS is a useful technique for determining elements bound to the humic and fulvic acid complexes and can help enhance background to anomaly contrast, this technique was not necessary for this study. This is because nearly all humus samples contained below detection Au determined by Na pyrophosphate ICP-MS making it an ineffective technique in determining Au contents for greenfield exploration.

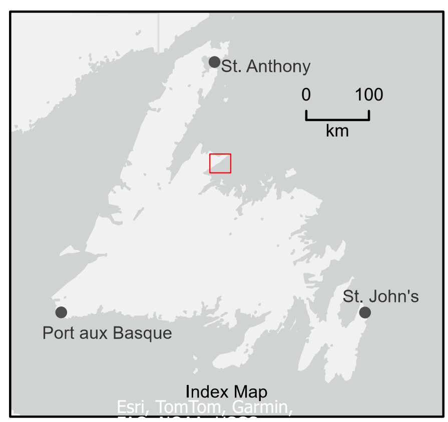
5) Field crews must be properly trained to identify humus in a soil horizon and extreme care must be taken while sampling to ensure that "dusty" humus or the underlying mineral soil are not sampled. Ideally, at least 750–1000 g of humus should be collected in the field. This is to ensure that sufficient material is available for analyses after drying, milling and sieving to the 180 µm fraction.



LEGEND ● Humus samples — Roads — Mineral occurrence: Silver, Copper, Gold, Zinc

A

Samples: 2022-SH111-2047, 2022-SH111-2048, 2022-SH111-2049, 2022-SH111-2050
Humus samples analyzed by Na pyrophosphate ICP-MS
Elevated: Ag + As + Cd + In + Pb + Sb
Anomalous: Hg + Sn + Mo + Se + An + Te + Zn
Humus samples analyzed by aqua regia ICP-MS
Elevated: Ag + Au + Bi + In + Pb + Pd + Sb + Sn
Anomalous: As +, Hg + Mo + Au + S + Te



B

Samples: 2022-SH111-2038
Humus samples analyzed by Na pyrophosphate ICP-MS
Anomalous: Ag + Bi + Se + Sn
Highly anomalous: As + Co + Cd + Cr + Cu + Hg + In + Mo + Ni + Sb + Te + Zn
Humus samples analyzed by aqua regia ICP-MS
Elevated: As + Cd + Mo + Ni + Au + S + Te
Anomalous: Cu + Cr
Highly anomalous: Co+ In + Pd

C

Samples: 2022-SH111-2039, 2022-SH111-2040, 2022-SH111-2040 FD 1, 2022-SH111-2040 FD2, 22022-SH111-041, 22022-SH111-2042, 2022-SH111-2043, 2022-SH111-2044, 2022-SH111-2045, 2022-SH111-2046
Humus samples analyzed by Na pyrophosphate ICP-MS
Elevated: Cr + In + Ni; Anomalous: Co; Elevated to anomalous: As + Bi + Cd + Cu + Pb + Sb + Se; Elevated to highly anomalous: Ag + Hg + Mo + Sn + Te + Zn
Humus samples analyzed by aqua regia ICP-MS
Elevated: Co + Cr; elevated to anomalous: Cd + Pd + Pt + Te ; Elevated to highly anomalous: Ag + As + Au + Bi + Cu + Hg + In + Mo + Ni + Pb + S + Sb + Se + Sn + Zn: Highly anomalous: Ag

Figure 24. *Geochemical anomalies in humus samples analyzed by both aqua regia ICP-MS and Na pyrophosphate ICP-MS in the Nippers Harbour map area (NTS 2E/13) that are not associated with known mineral occurrences.*

6) The analytical technique best suited to detect Au and its associated elements in humus samples in remote areas with little or no anthropogenic influence, is *aqua regia* ICP-MS on the 180 µm sieved and ashed sample to target Au content at ppt levels. Further, incorporating LOI for humus samples is a good practice because it can assist in quantifying inorganic contaminants. In areas where anthropogenic contamination is unlikely, incorporating a partial leach, such as Na pyrophosphate ICP-MS to detect anthropogenic contamination may not be required.

7) Of the analytical techniques used to detect Au and associated elements in till samples, an *aqua regia* ICP-MS on a 50 g till aliquot sieved to the <63 µm fraction is well-suited to Au recovery, whereas 4-acid ICP-MS on a 0.25 g till aliquot sieved to the <10 µm fraction is well-suited to the recovery of pathfinder elements.

CONCLUSIONS

A sampling program was conducted on the island of Newfoundland to evaluate the efficacy of detecting Au mineralization in humus. The primary objective of this study was to determine if humus can reflect the presence of Au and its associated pathfinder elements, to assist explorers in areas without exposed bedrock or insufficient till. The results of this study demonstrate that humus can reflect the presence of Au and its associated elements.

In the Jackson's Arm map area, up to 0.268 ppm Au, 36 ppm Ag, 0.008 ppm Pt and 0.009 ppm Pd are recovered from humus samples by ashed *aqua regia* ICP-MS. Spearman correlation matrix generated for humus samples analyzed by *aqua regia* ICP-MS shows that Au correlates weakly (r^2<70) with Te, and Ag correlates weakly with Cu, Te and Se.

In the Nippers Harbour map area, up to 0.0991 ppm Au, 7.3 ppm Ag, 0.007 ppm Pt and 0.01 ppm Pd are recovered from humus samples by ashed *aqua regia* ICP-MS. Spearman correlation matrix generated for humus samples analyzed by *aqua regia* ICP-MS shows that Au does not have a significant correlation with other elements; Au shows a weak correlation with Cu, Ag shows a strong correlation (r^2 > 70) with V, Pt shows a strong correlation with Se, whereas Pd does not show a significant correlation with any other element.

On Glover Island, up to 0.686 ppm Au, 21 ppm Ag, 0.049 ppm Pt and 0.015 ppm Pd are recovered from humus samples by ashed *aqua regia* ICP-MS. Spearman correlation matrix generated for humus samples analyzed by *aqua regia* ICP-MS indicates that Au shows a strong correlation with Se, Te and S, Pt shows a strong correlation with Re and S, whereas Pd does not show a strong correlation with any other element. Ag shows a strong correlation with Zn, whereas Ag analyzed by Na pyrophosphate ICP-MS shows a positive correlation with several elements including As, Cr, Bi, In, Sn and Mo.

Although higher associated element contents were recovered in the clay (<10 µm) fraction, analyzed by *aqua regia* ICP-MS, the highest Au content was recovered in the silt + clay (<63 µm) of a 50 g aliquot, analyzed by *aqua regia* and analyzed by ICP-MS ("AuME-ST44").

ACKNOWLEDGMENTS

This report was reviewed by Beth McClenaghan (Geological Survey of Canada), and Sara Jenkins (GSNL). Cartography and GIS support were provided by Kim Morgan and Joanne Rooney typeset the document. The author would like to acknowledge the following: Lisa Connors and Chris Finch (GSNL) and Amanda Stoltz (ALS Geochemistry) for brainstorming on analytical development and workflow, and sample preparation; Dave Copeland and Lindsey Gale (Signal Gold), and Tanya Tettelaar (Magna Terra Minerals) for data sharing and field tours around their properties in Jackson's Arm and Nippers Harbour; Jo Price, Alan Phillippe, Joel Cranford, Gabriel Sindol and Rory (Prospector Metal Corporation) for field tours of their properties around Twillingate; Sean Jackson and David Diekrup for providing enthusiastic lab and field assistance; Rick Follett (Newfoundland Helicopters) for piloting us safely and efficiently around Glover Island; Iyad Al-Khatib (ALS Geochemistry) and Alexandra Withers (Geoscience Laboratories) for analytical support; Nikita Oliver, Megan Reardon and Gerry Hickey for logistical support; and Riversea Motel (Jackson's Arm), Home Comfort B&B (La Scie), George's Ski rentals and Marblewood Village (Steady Brook), and Echoes of the Ocean (Twillingate) for providing accommodations.

REFERENCES

Advocate Mines Limited
1967: Diamond drilling data from Nippers Harbour area, Newfoundland. Advocate Mines Limited, Unpublished Report [GSB# 002E/13/0187.]

ALS Geochemistry
2022: ALS Geochemistry Fee Schedule CAD 2022. Retrieved from https://www.alsglobal.com/en/geochemistry/geochemistry-fee-schedules (retrieved May 2022).

Bajc, A.F. and Hall, G.E.M.
2000: Geochemical response of surficial media, North and East ranges, Sudbury Basin. Ontario Geological Survey, Open File Report 6033, 265 pages.

Basha, M., Frew, A., Cain, M.J., Woods, D.V., Kubo, W.K. and Leitch, C.H.B.
2001: First, seventh- and fifteenth-year assessment report on geological, geochemical, geophysical and trenching exploration for licenses 7584M7585M and 7588M7590M on claims in the Glover Island area, west central Newfoundland, 4 reports, New Island Resources Incorporated. Newfoundland and Labrador Geological Survey, Assessment File 12A/1183, 362 pages.

Batterson, M.J.
2003: Quaternary geography and sedimentology of the Humber River Basin and adjacent areas. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 03-2, 194 pages.

Batterson, M.J. and Liverman, D.G.E.
2001: Contrasting styles of glacial dispersal in Newfoundland and Labrador: Methods and case studies. *In* Prospecting in Areas of Glaciated Terrain. *Edited by* M.B. McClenaghan, P.T. Bobrowsky and N.J. Cook. The Geological Society London, Special Volume 185, pages 267-285.

Bruneau, Y.
1984: First year assessment report on geological, geochemical and geophysical exploration for license 2291 on claim block 2878 in the Jacksons Arm and Sops Arm areas, Newfoundland. Labrador Mining and Exploration Company Limited, Unpublished report, 15 pages.

Cawood, P.A., van Gool, J.A.M. and Dunning, G.R.
1996: Geological development of the eastern Humber and western Dunnage zones; Corner Brook Glover Island region, Newfoundland. Canadian Journal of Earth Sciences, Volume 33, pages 182-198.

Conliffe, J.
2021: Geochemical and hyperspectral data from gold occurrences in the Glover Island and Grand Lake areas, western Newfoundland (NTS map area 12A/12). Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Open File 012A/12/1845, 9 pages.

2022: VMS-style mineralization in the Kettle Pond Formation, Glover Island NTS map areas 12A/12 and 13). *In* Current Research. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Report 22-1, pages 1-28.

Colman-Sadd, S.P., Hayes, J.P. and Knight, I. (compilers)
1990: Geology of the Island of Newfoundland. Map 90-01. Scale 1:1 000 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Open File NFLD/2192.

Dunn, C.E.
1998: Geochemistry of humus from the southern La Ronge Domain, Saskatchewan (NTS 73P/7). Geological Survey of Canada, Open File 3345.

Fortescue, J.A.C.
1985: A standardized approach to the study of the geochemistry of humus, Williams Property Hemlo, Thunder Bay District. Ontario Geological Survey, Geochemical Series, Map 80754.

Geological Survey of Newfoundland and Labrador (GSNL).
2023a: Mineral Occurrence Database System (MODS). Newfoundland and Labrador GeoScience Atlas OnLine. Last update: December 2021. http://geoatlas.gov.nl.ca/ (retrieved January 2024).

2023b: "Striation Database" Newfoundland and Labrador GeoScience Atlas OnLine. Last update: November 2022. http://geoatlas.gov.nl.ca/ (retrieved October 2023).

Grant, D.R.
1974: Prospecting in Newfoundland and the theory of multiple shrinking ice caps. In Report of Activities. Geological Survey of Canada, Paper 74-1B, pages 215-216.

1986: Surficial geology, St. Anthony–Blanc Sablon, Newfoundland–Quebec. Geological Survey of Canada, Map 1610A. Scale 1:125 000.

1989: Quaternary geology of the Atlantic Appalachian region of Canada. *In* Quaternary Geology of Canada and Greenland. *Edited by* R.J. Fulton. Geological Survey of Canada, Geology of Canada, No. 1, pages 391-440.

Hall, G.E.M., Parkhill, M.A. and Bonham-Carter, G.F.
2003: Conventional and selective leach geochemical exploration methods applied to humus and B horizon soil overlying the Restigouche VMS deposit, Bathurst mining camp, New Brunswick. Economic Geology, Volume 11, pages 763-782.

Hall, G.E.M., Vaive, J.E. and MacLaurin, A.I.
1996: Analytical aspects of the application of sodium pyrophosphate reagent in the specific extraction of the labile organic component of humus and soils. Journal of Geochemical Exploration, Volume 56, pages 23-36. https://doi.org/10.1016/0375-6742(95)00046-1

Hashmi, S.
2018: Quaternary geology and surficial media sampling in Drury and Denison townships, City of Greater Sudbury. Ontario Geological Survey, Open File Report 6342, 133 pages.

2020: Surficial geological survey in support of mineral exploration, Great Northern Peninsula: Preliminary results from the St. Julien's map area. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 20-1, pages 71-86.

2021: Preliminary interpretation of till geochemistry: Cormack (NTS 12H/06) and Silver Mountain (NTS 12H/11) map areas, western Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Report 21-1, pages 97-120.

2023a: Humus as a sample medium to target Au mineralization in Newfoundland: Preliminary data from Glover Island (NTS 12A/12 and 13), Jackson's Arm (NTS 12H/15) and Nippers Harbour (NTS 2E/13) map areas. *In* Current Research. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Report 23-1, pages 1-21.

2023b: Humus and till geochemistry as exploration tools for Au mineralization in Newfoundland: Data from Glover Island (NTS 12A/12 and 13), Jackson's Arm (NTS 12H/15) and Nippers Harbour (NTS 2E/13) map areas. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Open File NFLD/3440, 16 pages.

Hashmi, S., Leybourne, M.I., Hamilton, S., Layton-Matthews, D. and McClenaghan, M.B.
2022: Suitability of surficial media for Ni–Cu–PGE exploration in an established mining camp: A case study from the South Range of the Sudbury Igneous Complex, Canada. Geochemistry: Exploration, Environment, Analysis, Volume 22.
https://doi.org/10.1144/geochem2021-051

Harrington, M. and Cullen, M.
2022: NI-43101 Technical report and updated mineral resource estimate on the Rattling Brook gold deposit, Great Northern project, White Bay area, Newfoundland and Labrador, Canada. Magna Terra Minerals Inc., 165 pages.

Honsberger, I.W., Bleeker, W., Kamo, S.L., Evans, D.T.W. and Sandeman, H.A.I.
2019: A Neoproterozoic age for granodiorite underlying Rogerson Lake Conglomerate: Confirmed Ganderian basement in the Wilding Lake area, central Newfoundland gold district. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File 012A/07/ 1774, 12 pages.

Kauranne, L.K., Salminen, R. and Eriksson, K.
1992: Handbook of Exploration Geochemistry, Volume 5: Regolith Exploration Geochemistry in Arctic and Temperate Terrains. Elsevier, 443 pages.

Kerr, A.
2006: Silurian rocks of the Sops Arm group, western Newfoundland: Some new food for future digestion. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 06-1, pages 91-177.

Kerr, A. and Knight, I.
2004: Preliminary report on the stratigraphy and structure of Cambrian and Ordovician rocks in the Coney Arm area, western White Bay (NTS map area 12H/15). *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 04-1, pages 127-156.

Knapp, D.A.
1982: Ophiolite emplacement along the Baie Verte-Brompton Line at Glover Island, western Newfoundland. Unpublished Ph.D. thesis. Memorial University of Newfoundland, St. John's, Newfoundland, 338 pages.

Leybourne, M.I. and Cameron, E.M.
2010: Groundwater in geochemical exploration. Geochemistry: Exploration, Environment, Analysis, Volume 10, pages 99-118.
https://doi.org/10.1144/1467-7873/09-222

Liverman, D.G.E.
1992: Application of regional Quaternary mapping to mineral exploration, northeastern Newfoundland, Canada. Transactions of the Institution of Mining and Metallurgy, Volume 101, pages 89-98.

1994: Relative sea-level history and isostatic rebound in Newfoundland, Canada. Boreas, Volume 23, pages 217-230. https://doi.org/10.1111/j.1502-3885.1994.tb00944.x

McClenaghan, M.B., Paulen, R.C., Ayer, J.A., Trowell, N.F. and Bauke, S.D.
1998: Regional till and humus geochemistry of the Timmins-Kamiskotia area, northeastern Ontario (NTS 42A/11, 12, 13, 14). Geological Survey of Canada, Open File Report 3675, 287 pages.

McClenaghan, M.B., Spirito, W.A., Plouffe, A., McMartin, I., Campbell, J.E., Paulen, R.C., Garrett, R.G., Hall, G.E.M., Pelchat, P. and Gauthier, M.S.
2020: Geological Survey of Canada till-sampling and analytical protocols: from field to archive, 2020 update. Geological Survey of Canada, Open File 8591, 1 zip file. https://doi.org/10.4095/326162

McCuaig, S.J.
2003: Till geochemistry of the White Bay area. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Open File, NFLD 2823, 51 pages.

McCuaig, S.J., Liverman, D.G.E. and Taylor, D.M.
2006: Till geochemistry of the Glover Group, western Newfoundland (NTS map areas 12A/12 and 12A/13). Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File 012A/1209, 84 pages.

McMartin, I., Henderson, P.J., Nielsen, E. and Campbell, J.E.
1996: Surficial geology, till and humus composition across the Shield Margin, north-central Manitoba and Saskatchewan: Geospatial analysis of a glaciated environment. Geological Survey of Canada, Open File 3277.

Minnett, M., Sandeman, H.A. and Wilton, D.
2010: Regional setting of gold mineralization at the Viking property, southern White Bay, Newfoundland. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 10-1, pages 51-64.

Pilote, J.L., Piercey, S.J.P. and Mercier-Langevin, P.
2014: Stratigraphy and hydrothermal alteration of the Ming Cu-Au volcanogenic massive sulphide deposit, Baie Verte Peninsula, Newfoundland. *In* Current Research. Geological Survey of Canada, Report 2014-7, 18 pages. https://doi.org/10.4095/295145

Pronovost, J.M. and Helt, K.
2013: First year assessment report on prospecting, mapping and geochemistry for licenses 020851M, 020852M and 021037M in the La Scie area, Newfoundland. Bowmore Resources Ltd. Unpublished report, 85 pages.

Puritch, E. and Barry, J.
2017: Technical report and resource estimate on the Glover Island Gold Property, Grand Lake area west central Newfoundland, Canada. NI 43-101 & 43-101 F1 technical report for Mountain Lake Minerals Inc. by P&E Mining Consultants Inc., 118 pages.

Rogers, P.J. and Dunn, C.E.
1993: Trace element chemistry of vegetation applied to mineral exploration in eastern Nova Scotia, Canada. Journal of Geochemical Exploration, Volume 48, pages 71-95. https://doi.org/10.1016/0375-6742(93)90082-W

Sandeman, H.A.I.
2014: Viking gold deposit (NTS map area 12H/11), lithogeochemical database. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File 012H/11/2107, 20 pages.

Sangster, A.L., Douma, S.L. and Lavigne, J.
2008: Base metal and gold deposits of the Betts Cove Complex, Baie Verte Peninsula, Newfoundland. Geological Association of Canada, Mineral Deposits Division, Special Publication 5, pages 703-723.

Shaw, J., Piper, D.J.W., Fader, G.B.J., King, E.L., Todd, B.J., Bell, T., Batterson, M.J. and Liverman, D.G.E.
2006: A conceptual model of the deglaciation of Atlantic Canada. Quaternary Science Reviews, Volume 25, pages 2059-2081.

Signal Gold Inc.
2022: Tilt Cove Project. https://www.signalgold.com/operationsprojects/thetiltcoveproject (accessed 20th December 2022).

Skulski, T., Castonguay, S., McNicoll, N., van Staal, C., Kidd, W., Rogers, N., Morris, W., Ugalde, H., Slavinski, H., Spicer, W., Moussallam, Y. and Kerr, I.
2010: Tectonostratigraphy of the Baie Verte oceanic tract and its ophiolitic cover sequence on the Baie Verte Peninsula. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 10-1, pages 315-335.

Skulski, T., Castonguay, S., van Staal, C., Rogers, N., McNicoll, M., Kerr, A. and Escayola, M.
2009: Baie Verte Peninsula: An evolving geological history. Geological Association of Canada, Newfoundland and Labrador Branch, Annual Fall Field Trip, October, 2nd–5th.

Szybinski, Z.A., Brem, A.G., van Staal, C.R., Whalen, J., McNicoll, V.J., Jenner, G. and Piercy, S.J.
2006: Geology, Little Grand Lake, Newfoundland and Labrador. Geological Survey of Canada, Open File 1668, scale 1:50 000.

Tuach, J.
1986: Metallogeny of Newfoundland granites – studies in the western White Bay area and on the southwest coast. *In* Current Research. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 86-1, pages 27-38.

van Staal, C.R.
2007: Pre-Carboniferous tectonic evolution and metallogeny of the Canadian Appalachians. *In* Mineral Deposits of Canada: A Synthesis of Major Deposit types, District Metallogeny, The Evolution of Geological Provinces and Exploration Methods. *Edited by* W.D. Goodfellow. Geological Association of Canada, Mineral Deposits Division, Special Publication No. 5, pages 793-818.

van Staal, C.R., Whalen, J.B., McNicoll, V.J., Pehrsson, S.J., Lissenberg, C.J., Zagorevski, A., van Breemen, O. and Jenner, G.A.
2007: The Notre Dame Arc and the Taconic orogeny in Newfoundland. *In* 4D Framework of Continental Crust. *Edited by* R.D. Hatcher, Jr., M.P. Carlson, J.H. McBride and J.R. Martínez Catalán. Geological Society of America, Memoir 200, pages 511-552.

Wallace, J. and Wesa, G.L.
1988: First- and second-year assessment report on geological and geochemical exploration for license2661 on claim block 4253, license 2665 on claim blocks 4254-4258, license2975 on claim block 4590, license2976 on claim block 4591, license3150 on claim block 5259 and license 3151 on claim block 5260 in the Nippers Harbour and Rogues Harbour areas on the Baie Verte Peninsula, Newfoundland. Varna Gold Incorporated and South Coast Resources Incorporated Unpublished report, 195 pages. Newfoundland and Labrador Geological Survey, Assessment File 002E/13/0615.

Westhues, A.
2022: Geochemical data from gold mineralized quartz veins and related host rocks, Little River area/Kendell showing, St. Alban's (NTS map area 1M/13), south coast of Newfoundland. Government of Newfoundland and Labrador, Department of Industry, Energy and Technology, Geological Survey, Open File 001M/13/0970, 6 pages.

Williams, H.
1979: Appalachian orogen in Canada. Canadian Journal of Earth Sciences, Volume 16(3), pages 792-807. https://doi.org/10.1139/e79-070

Windfinder, 2024:
Annual wind and weather statistics. Retrieved from https://www.windfinder.com/windstatistics (retrieved May 2024).

APPENDICES

Appendices A–D are included in the OF_NFLD_3458 zip folder as Excel (xlsx) files and Appendices E–G as Adobe (pdf) files.

APPENDIX A: Humus LOI% Data and Geochemical Data Determined by *Aqua Regia* ICP-MS and Na Pyrophosphate ICP-MS for the <180 µm Fraction

Geochemical data is from the following analyses: 1) Na pyrophosphate ICP-MS on the <180 µm humus fraction, and 2) *aqua regia* ICP-MS on the <180 µm humus fraction.

APPENDIX B: Till Particle Size Analysis, LOI% and Geochemical Data for the <63 µm and <10 µm Fraction

Geochemical data is from the following analyses: 1) 4-acid digestion ICP-MS on the <63 µm till fraction, 2) 4-acid digestion ICP-MS on the <10 µm till fraction, 3) *aqua regia* ICP-MS on the <63 µm till fraction, and fire assay ICP-AES on the <63 µm till fraction.

APPENDIX C: Correlation Matrix Generated for Humus Geochemistry – Sodium Pyrophosphate Digestion

APPENDIX D: Correlation Matrix Generated for Humus Geochemistry – *Aqua Regia* digestion.

APPENDIX E: XYZ Plots for Associated Elements

APPENDIX F: Proportional Dot Plots of Pathfinder Elements for Humus Samples Analyzed by *Aqua Regia* ICP-MS and Till Samples.

APPENDIX G: Proportional Dot Plots of Pathfinder Elements for Humus Samples Analyzed by Na Pyrophosphate ICP-MS