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GEOLOGY, LITHOGEOCHEMISTRY AND MINERALIZATION AT THE SOUTH WOOD LAKE GOLD PROSPECT (STAGHORN PROPERTY), EXPLOITS–MEELPAEG SUBZONES BOUNDARY, WESTERN-CENTRAL NEWFOUNDLAND

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ABSTRACT

The Staghorn gold property in NTS map area 12A/4 of western–central Newfoundland is situated along the southwestern boundary area between the Exploits, Meelpaeg and Notre Dame subzones of the Newfoundland Appalachians. The property includes three significant gold showings (Hilltop, Sure Shot, Falls) and one drilled prospect, the South Wood Lake (Main) zone. These discoveries have occurred episodically through grassroots prospecting since the 1970s. Exploration work including detailed ground geophysics, trenching and drilling, along with mapping, petrography and lithogeochemistry, collectively demonstrate that the mineralization at the Main zone is hosted by variably textured, mylonitized and brecciated, commonly strongly lineated, Mu±Bt monzogranite to granodiorite of the Ordovician (467 ± 6 Ma) Peter Strides granite suite. Mineralization consists of a network of thin (≤10 cm), anastomosing, quartz–pyrite–hematite±arsenopyrite veins, fractures and accompanying wall-rock sericitization and silicification. Gold is accompanied by elevated Bi, Sb, Cd, Ag and Te, and, in particular, strongly elevated As. Tiny native gold grains (<10μm) and small Bi-tellurides (<20μm) were noted in a vein and vein margin, respectively. Bournonite ($PbCuSbS_3$) forms thin films on euhedral pyrite. The mineralized, brecciated and mylonitic monzogranite occurs as imbricate slices in the structural hanging wall of the northeast-trending, south-dipping Victoria Lake shear zone. The South Wood Lake gold prospect occurs in the antiformal core of a km-scale, post-mylonitization, Z-asymmetric flexure of the shear zone. Mineralization is likely post-Silurian.

INTRODUCTION

The Staghorn exploration property contains the South Wood Lake gold prospect, located on the southern shore of Wood Lake, 75 km south on the Burgeo Highway (Highway 480) from the junction with the Trans-Canada Highway. The prospect is situated in the King George IV map area (NTS 12A/4: Figure 1), ~6 km west southwest of Highway 480, and may be accessed *via* abandoned logging roads using an all-terrain vehicle.

This part of western–central Newfoundland forms a series of northeast–southwest-trending valleys and ridges, where bedrock is typically restricted to ridges and local river exposures. Valleys contain interconnected streams, bogs and ponds and preserve a thick hummocky terrain of ablation and basal till and abundant local fluvial gravels (Liverman and Taylor, 1990; Sparkes and McQuaig, 2005). The thick glacial till blanket in the valleys, in conjunction with younger fluvial deposits make intact bedrock outcrop scarce, typically «1%. Very rare unidirectional striae indicate ice flow from the northeast in a fanning pattern to the southwest and west (Sparkes and McQuaig, 2005). Less common bidirectional striae suggest a younger component of southeast to northwest ice movement.

Prior to the construction of the Burgeo Highway in the early 1970s and systematic 1:50 000- scale geological mapping, little exploration or fundamental academic work had been completed in the prospect area. Largely because of the paucity of exposed bedrock, the geological database for this part of western–central Newfoundland is sparse (Riley, 1957; DeGrace, 1973; Kean, 1983; Dunning *et al.*, 1990; van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006) making interpretation of the setting and nature of mineralization in the area difficult. Robust lithogeochemical data are generally lacking for rocks of the prospect, although a few representative 'modern' data are presented in Rogers (2004). Geochronological data consist of eight U–Pb zircon (TIMS) ages. Dunning *et al.* (1990) reported 2 U–Pb ages for Siluri-

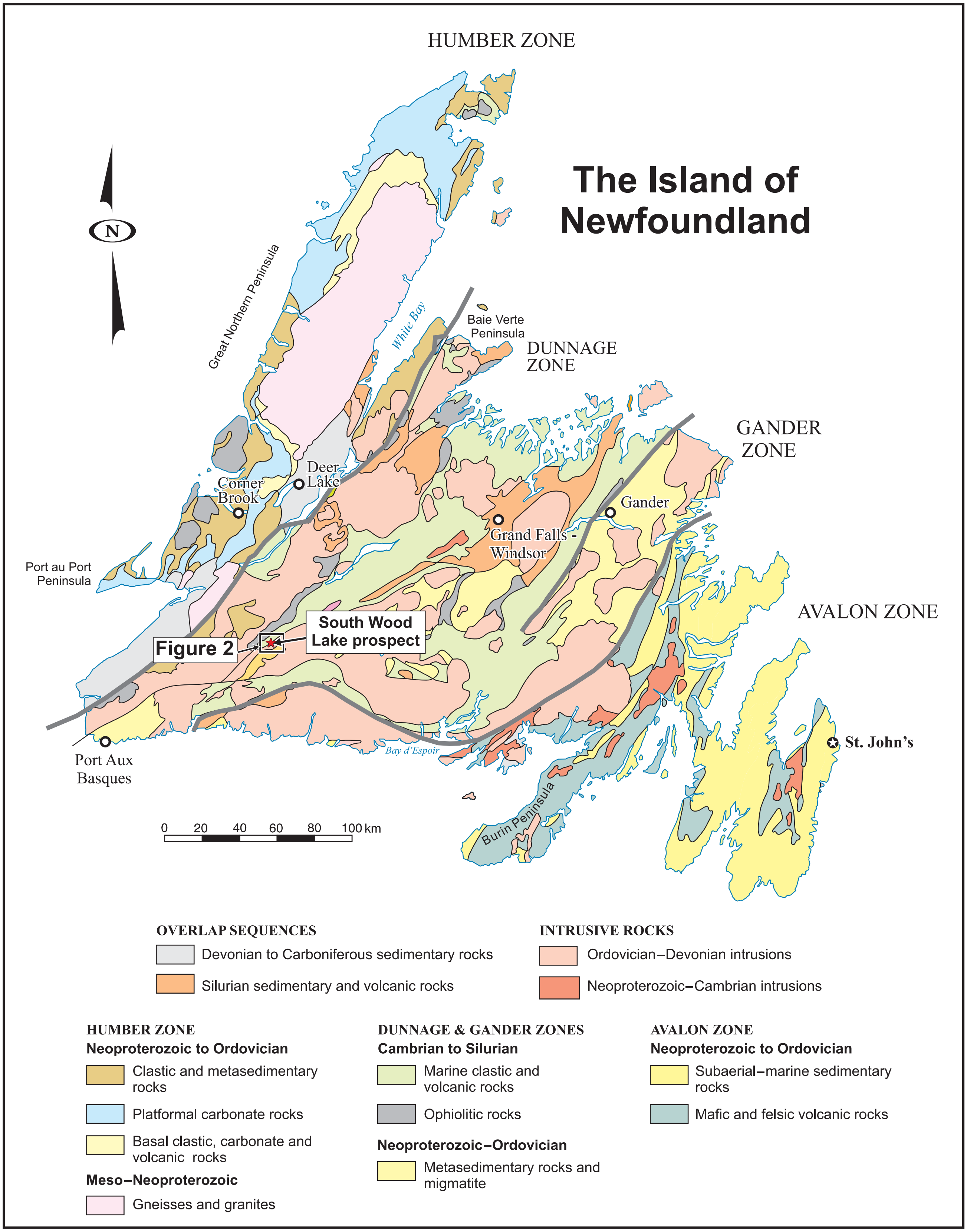


Figure 1. *Simplified geological map of the Island of Newfoundland showing the location of the King George IV map sheet and the South Wood Lake prospect.*

an rocks, whereas van Staal *et al.* (2005) and Valverde-Vaquero *et al.* (2006) reported ages of 467 ± 6 Ma and 458 ± 3 Ma for two different phases of the Peter Strides granite suite. van Staal *et al.* (2005) also reported an age of 463 ± 3 Ma for a felsic tuff of the Red Indian Lake Group; an approximate age of *ca.* 473 Ma for a felsic tuff of the Buchans Group; and an approximate age of *ca.* 487 Ma for a felsic tuff of the Pats Pond Group of the Victoria Lake supergroup. The present contribution discusses the exploration history of the region around the South Wood Lake prospect, reports robust lithogeochemistry for select rocks from the area, including mineralized and non-mineralized rocks and, outlines the nature and geological setting of the mineralization.

PREVIOUS WORK AND REGIONAL SETTING

The King George IV Lake area was initially mapped at 1:250 000 scale by Riley (1957) who outlined the variety and general disposition of rock types. The area in the vicinity of King George IV Lake was mapped at a scale of 1" = 1 mi. for the Newfoundland Department of Mines and Energy (DeGrace, 1973) but did not greatly expand the understanding of the geology. Parts of the study area were also mapped by Swanson (1959) and Thurlow *et al.* (1980) during regional mineral work driven by base-metal exploration. Smyth (1979) produced a 1:50 000-scale compilation of the geology of the area based on mapping and confidential exploration data supplied at that time by the Buchans Mining Company (*in* Kean, 1983).

During the widespread survey mapping programs of the early 1980s, Kean (1983) mapped the King George IV Lake map area (12A/4) at a scale of 1:50 000. BP-Selco carried out exploration activities in the region from 1987-88 (the southern Victoria Lake area) that included the evaluation of the gold and base-metal potential of the area near Wood Lake. Therein, soil and rock sampling were undertaken on 2500 and 10 000 m^2 grids, and the surveys yielded several anomalous gold-in-soil values that resulted in the excavation of five trenches (the Sure Shot showing: Figure 2). Further details of the work are not known, but several rock samples taken from the trenches are reported to have returned anomalous gold values.

The most recent and directly pertinent historical work was completed in the study area between 1997 and 2002 by prospectors Gilbert Lushman and Edwin Northcott. On a grid immediately to the north of Wood Lake, soil and till samples were collected: the till samples were panned to a heavy mineral concentrate, and then both soils and tills were analyzed. These yielded minor anomalous gold-in-soil values (<5 to 22 ppb Au) but highly anomalous (<5 to 1189 ppb Au) gold-in-till samples (Northcott, 1997, 1998). Subsequently, Lushman and Northcott panned the shore line of Wood Lake and encountered numerous visible gold grains in the concentrates, in particular along the south shore. In the following year they shifted exploration to the south of Wood Lake and collected further soil, rock, till and stream sediment samples (Northcott, 2000). Gold-in-soil assays along a baseline paralleling the south shore of the lake ranged from 55 to 354 ppb gold, and notable gold assays returned from 20 of the 57 samples taken. In 2002, at the site where highest gold-grain-counts in panned concentrate occurred, Lushman and Northcott excavated two adjacent trenches, collectively termed the Main trench; this became the South Wood Lake gold prospect (Northcott, 2002). Numerous test-pits were also excavated in the area in unsuccessful attempts to reach bedrock. As a result of the rising price of gold, a series of property examinations were undertaken by exploration companies, that proved the occurrence of anomalous gold values from mineralized rock and float, ranging from 117 to 16 765 ppb over an area measuring 450 x 150 m. Several other gold-mineralized areas were also identified through this work and those yielded gold assays ranging from 4000 to 25 000 ppb. In late 2002, following the property examinations, Candente Resources Corporation (Candente) optioned the Staghorn property.

In 2003, Candente carried out exploration on their property that included a reinterpretation of a 1981 airborne magnetic/EM survey, to aid in the interpretation of the structure and geology of the area and to identify magnetic anomalies. Candente also collected 15 lake-bottom sediment samples, 89 rock samples (float, grab and channel) and completed geological mapping (van Egmond *et al.*, 2003). The 89 rock samples included 49 one-metre channel samples from trenches TR-02-1 to TR-02-3 in the Main trench area on the south shore of Wood Lake (Figures 2 and 3); 5 subcrop samples from historic pits dug in overburden; 12 selected outcrop samples from traverses south of Wood Lake and; 23 angular, likely locally derived 'float' rock samples. Gold assays for all of the rock samples ranged from <5 to 25 700 ppb Au, with many in the 3000 to 5000 ppb range. In addition, arsenic concentrations ranged from 1000 to >10 000 ppm, bismuth from 5 to 65 ppm, tungsten from <10 to 271 ppm and, tellurium concentrations up to 7.0 ppm (van Egmond *et al.*, 2003; van Egmond, 2004; van Egmond and Cox, 2005). The metals zinc, lead and cadmium were also noted to be elevated. Bismuth was suggested to be a key pathfinder element, postulated as occurring as bismuthite, Bi–Au alloys, or Bi–Te–Pb–Au–S compounds. Elevated arsenic was noted to generally correlate with gold, but gold did not necessarily correlate with arsenic (van Egmond *et al.*, 2003; van Egmond, 2004; van Egmond and Cox, 2005). Native gold was panned from surficial materials overlying bedrock, but visible gold was not noted in rock samples.

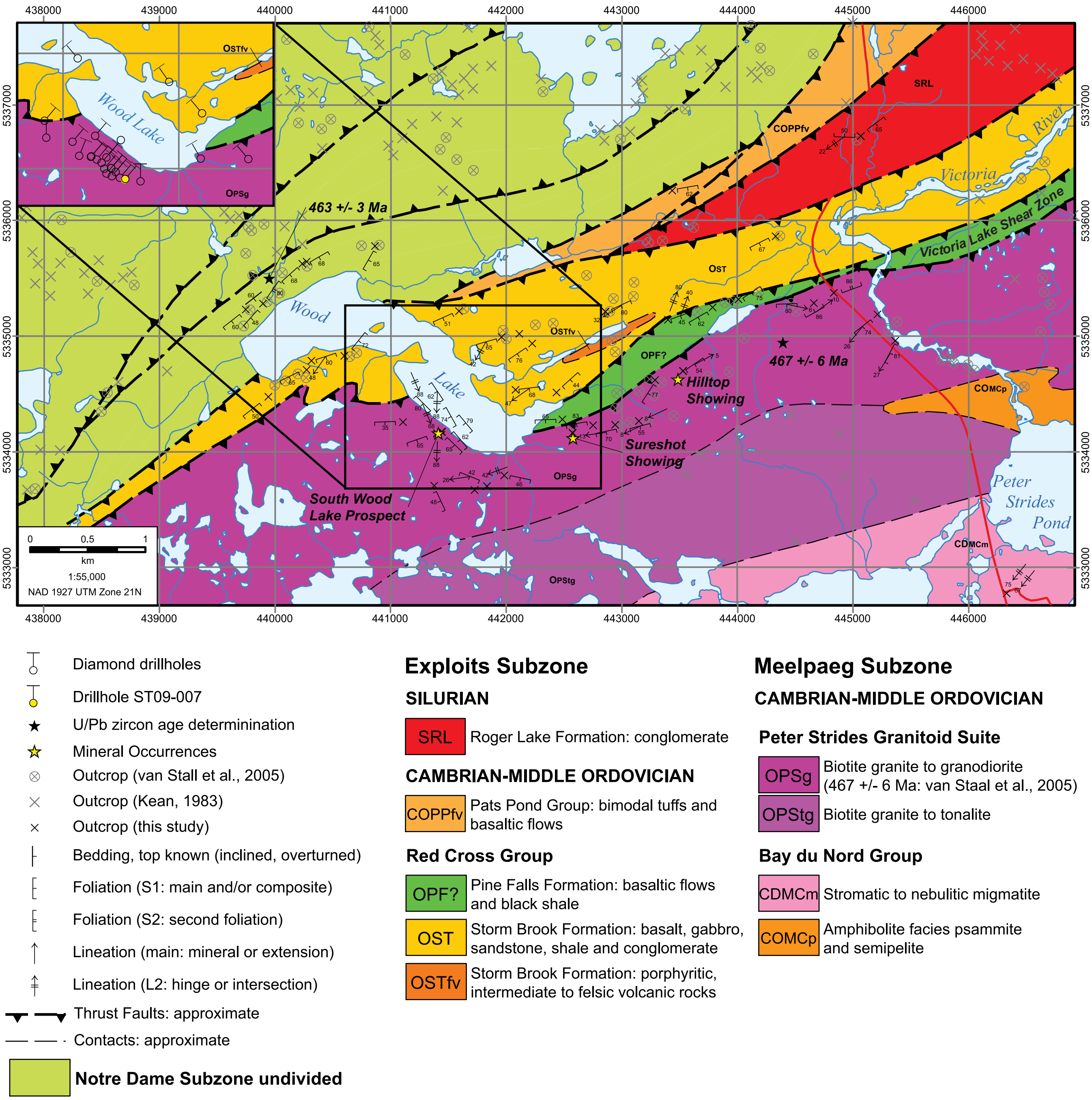


Figure 2. *Simplified geological map of the area around Wood Lake and Peter Strides Pond showing the location of the Sure Shot and Hilltop gold showings and the South Wood Lake prospect. Adapted from Kean (1983) and van Staal* et al. *(2005). All contacts and inferred thrust faults are approximate. The Falls showing (Reid and Myllyallo, 2010) lies ~4 km to the southwest of the South Wood Lake prospect. Inset map details the area around the prospect and shows the drillhole locations, particularly ST09-007 (highlighted in yellow).*

A 12 hole, 1868-m-drill program was undertaken in 2005 (van Egmond and Cox, 2005) that targeted the mineralization exposed in the Main trench as well as a number of Induced Polarization (IP) chargeability highs and other structural features inferred from ground magnetics and air-photo interpretation. Three of the drillholes intersected the gold mineralization and its strike extension. The best grades and widths of gold mineralization included 1.49 g/t over 1.5 m, 1.69 g/t over 1.5 m, 2.01 g/t over 0.9 m, 6.25 g/t over 1.0 m and 11.25 g/t over 1.5 m within two larger intervals of

1.47 g/t over 22.5 m and 0.23 g/t over 52.9 m from the respective holes (van Egmond and Cox, 2005). The property was returned to the vendors in 2006.

In 2008, Metals Creek Resources (Metals Creek) optioned the property and also obtained additional claims along strike from the known mineralization. Metals Creek carried out a program of line-cutting, and magnetic surveying on the South Wood Lake gold prospect as well as regional geochemical sampling on their entire claim holdings. The geochemical program outlined a new alteration zone at the Falls showing (2 km to the southwest of the western edge of Figure 2 (Reid, 2009). There, anomalous assays were in the 0.5 g/t range but proximal high-grade float samples yielded up to 197 g/t Au. Metals Creek also clearly outlined that the South Wood Lake gold prospect is spatially associated with a curvilinear magnetic low. The moderate to strong gold- and arsenic-in-soil anomalies at the prospect are coincident with, and down topographic slope from, the surface projected magnetic low.

Realizing further drilling was necessary, in 2009 Metals Creek drilled 13 holes totaling 1788 m on the South Wood Lake prospect; these stepped out in 50 m spacings to the southeast and northwest of the Main trench and covered 550 m of strike length. All holes had northeast or north azimuths and intermediate (45°) dips. All 2009 drillholes intersected mineralized silicic granitoid rocks having wide intervals of low-grade anomalous gold (*e.g.*, ST09-002: 26.31 m @ 1.37 g/t Au) and narrower intervals of higher grade gold (*e.g.*, ST09-002: 5.11 m @ 6.18 g/t Au: Reid and Myllyaho, 2010). Further drilling along strike has been recommended.

GEOLOGICAL SETTING OF THE PROSPECT

The area has most recently been mapped and reinterpreted at 1:50 000-scale by van Staal *et al.* (2005) as part of the TGI3 mapping initiative and who also provided a refined subdivision of the geological units in the area, based upon mapping, lithological correlation, U–Pb geochronology and lithogeochemistry. A major factor contributing to the difficulty of interpreting the geology is that it occurs near the juncture of three lithotectonic domains that include from south to north; the Meelpaeg, Exploits and Notre Dame–Dashwoods subzones (Williams *et al.*, 1988; van Staal *et al.*, 2005). Here, the Exploits Subzone rocks are highly attenuated and constitute a ≤3-km-wide strip. In the King George IV map area, the Meelpaeg Subzone rocks consist of amphibolite-facies grade and lower, dominantly metasedimentary and granitic intrusive rocks of inferred Ganderian affinity (Gander Zone: Williams *et al.*, 1988; van Staal, 2007). These include: the Bay du Nord Group (Units COMCp and CDMCM: Figure 2), the Peter Strides granite suite (Units OPSg and OPStg: Figure 2) and; the Devonian North Bay granite suite (403 ± 3 Ma: van Staal *et al.*, 2005), which outcrops ~8 km to the south of Wood Lake. The Ordovician Bay du Nord Group (466 ± 3 Ma: Dunning *et al.*, 1990) consists of black shale, siltstone, sandstone and rare volcanic rocks that, on the basis of geochronology and stratigraphic correlation, are considered to constitute rocks of the Exploits Subzone (Figure 2). In the map area, rocks of the Bay du Nord Group are amphibolite-facies-grade equivalents (Plate 1) that were intruded by metaluminous to peraluminous tonalite to monzogranite of the Peter Strides granite suite at 467 ± 6 Ma (van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). Exposures of Peter Strides granite suite rocks distal from mineralization consist of moderately foliated, typically fine- to medium-grained, biotite±muscovite granodiorite and have accessory magnetite, titanite, apatite, and zircon (Plate 2). These granitoids intrude rocks of both the Exploits and Meelpaeg subzones and as such stitch the boundary (Valverde-Vaquero *et al.*, 2006). During northward transport of the Meelpaeg nappe during the Silurian Salinic orogeny (Dunning *et al.*, 1990; van Staal *et al.*, 2008), the Bay du Nord Group and Peter Strides granite suite were structurally thickened and metamorphosed to amphibolite-facies grade, stromatic and nebulitic migmatite, psammite, semipelite, tonalite and monzogranite. The Peter Strides granite suite contains abundant schliera, xenoliths, screens and rafts of amphibolite-facies grade Bay du Nord Group rocks, locally conveying a gneissose appearance in outcrop. van Staal *et al.* (2005) and Valverde-Vaquero *et al.* (2006) recognized that the northern boundary of the Peter Strides granite suite, now defined by the Victoria Lake shear zone, represents a mylonitized, northwest-directed Siluro-Devonian thrust where rocks of the Meelpaeg Subzone structurally overlie those of the Exploits Subzone. The South Wood Lake gold prospect occurs in, and adjacent to,

Plate 1. *Field photograph of representative gneissose, semi-pelitic to pelitic biotite–muscovite paragneiss exposed south of Peter Strides Pond (location HS10-167: UTM coordinates NAD27, zone 21, 446326 E, 5332777 N). The $2 coin is 28 mm in diameter.*

Plate 2. *Field photograph of representative, lineated, non-mineralized Peter Strides suite granodiorite with biotitic schliera (sample HS10-168: UTM coordinates NAD27, zone 21, 445365 E, 5334962 N). The $2 coin is 28 mm in diameter.*

Plate 3. *Field photograph of representative chlorite schist of the Storm Brook Formation (sample HS10-26: UTM coordinates NAD27, zone 21, 444329 E, 5335869 N). The $2 coin is 28 mm in diameter.*

this fault zone. Structurally below the rocks of the Meelpaeg Subzone are the greenschist-grade rocks of the Exploits Subzone (Kean, 1983; van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). Rocks in the immediate footwall of the Victoria Lake shear zone are interpreted as the Middle to Late Ordovician Pine Falls Formation of the Red Cross Group (Kean and Jayasinghe, 1980; van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). In its type locality, ~100 km to the northeast, the Pine Falls Formation consists of a sequence of dominantly normal-mid-ocean ridge basalt (N-MORB) and island-arc tholeiite (IAT) basalt and associated hypabyssal intrusive rocks (Valverde-Vaquero *et al.*, 2006).

Structurally below the Pine Falls Formation is the Storm Brook Formation, also part of the Red Cross Group (van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006: Figure 2). In the South Wood Lake prospect area, the Storm Brook Formation is dominated by chlorite schist that has a strong foliation (Plate 3) and a well-developed chlorite lineation. Sparse, mesoscopic folds of the foliation dominantly plunge to the south and east. These chlorite schists are locally interlayered, on a decametre scale, with grey and black siltstones exhibiting centimetre- to millimetre-scale beds. Felsic volcanic sandstones, schistose felsic tuffaceous and conglomerates are subordinate. Geochemically, basaltic rocks of the Storm Brook Formation are typically enriched-MORB (E-MORB) varying to alkali-ocean basalt (OIB). Rocks of the Red Cross Group structurally overlie rocks of the Notre Dame Subzone to the north and northwest.

GEOLOGY OF THE SOUTH WOOD LAKE PROSPECT

Exposure around the South Wood Lake gold prospect is poor, but sparse subcrop, felsenmeer and trenched bedrock exposures indicate that the mineralization is hosted by massive, varying to brecciated and mylonitic, orange-pink monzogranitic rocks. Regionally, these are inferred to constitute part of the Peter Strides Granitoid Suite (*e.g.*, van Egmond, 2004; van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). Trenching at the South Wood Lake gold prospect was successful in uncovering two isolated exposures and minor subcrop of quartz-veined and silica–sericite–pyrite±arsenopyrite-altered, variably textured monzogranite. The trenches at the prospect (Figure 3) expose an ~3- to 5-m-wide zone of mylonitized, orange-pink monzogranite having an intense, southeast-trending foliation (~130°) dipping ~60-70° to the southwest (Plate 4A). These mylonitic fabrics starkly contrast with the dominant northeast-trending foliations observed to the east, near the Hilltop showing and to the west-northwest in exposures of Storm Brook Formation (Figures 2 and 3).

The mylonitic monzogranite exposed in the Main trench structurally overlies a mineralogically similar, but typically massive and/or brecciated, fine-grained sericitic monzogranite. The monzogranite is extensively crosscut by an array of steeply dipping irregular fractures (Plate 4B) and anastomosing, pinch-and-swell quartz veins (≤10 cm: Plate 4C). Both the veins and fractures are characterized by minor pyrite+hematite±arsenopyrite and are accompanied by adjacent wall-rock sericitization, albitization and silicification. White mica locally forms roseate masses in the matrix of brecciated monzogranite but occurs more typically as wispy platelets along planar fractures. Iron oxide (hematite?) is paragenetically late, forming mantles on remnant pyrite grains and also occurs as dusty fracture-fill with limonite(?). The hematization of the pyrite and subsequent hydration of the hematite to limonite likely imparts a characteristic

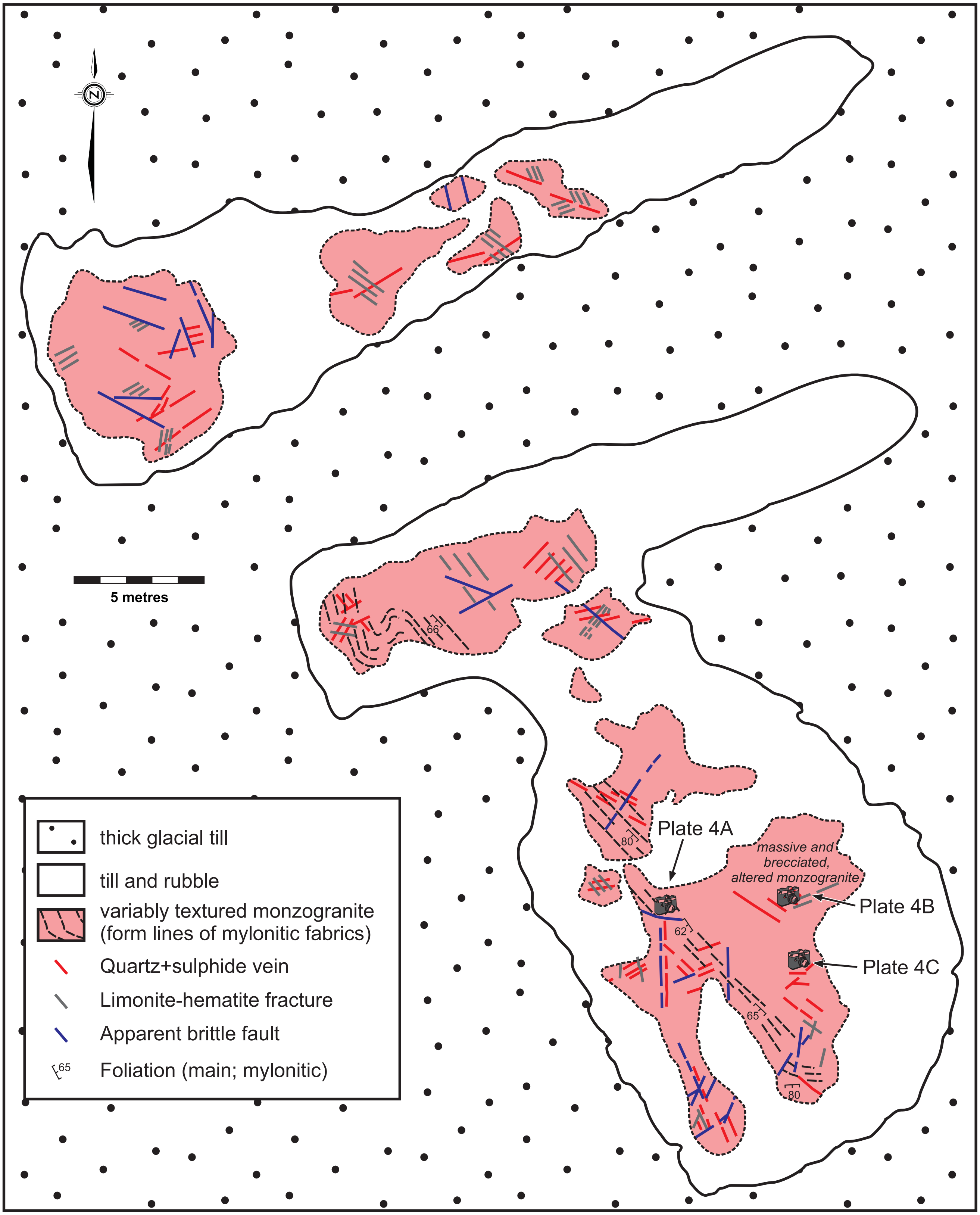


Figure 3. *Map showing bedrock exposure, mylonitic fabric preservation and quartz vein and sulphidic fracture orientations at the Main trench, South Wood Lake gold prospect. Adapted from van Egmond (2004). Note the locations of Plates 4A, B and C.*

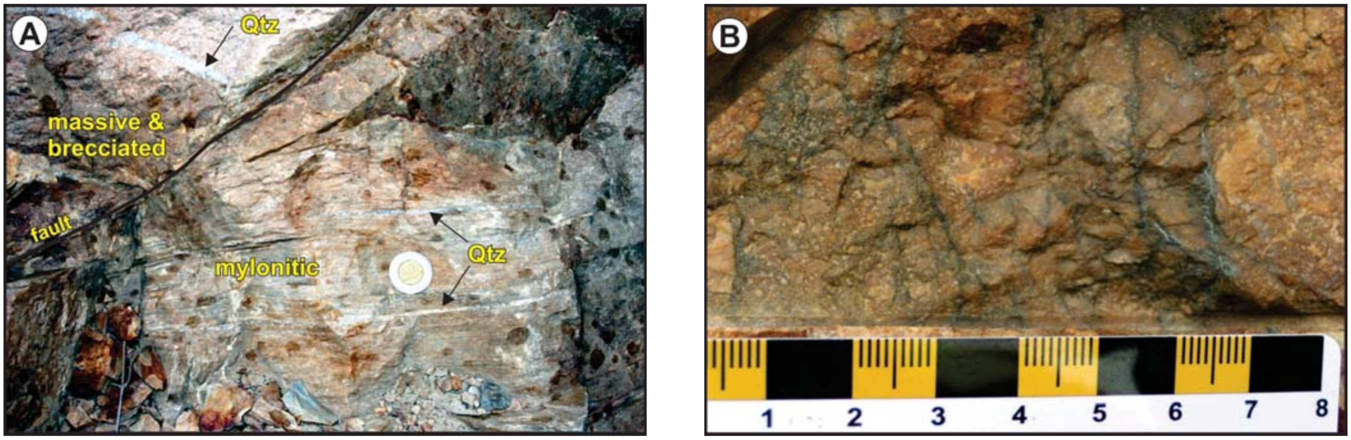


Plate 4. *Representative photographs of altered, mineralized and quartz-veined, variably textured monzogranite exposed in the Main trench at the South Wood Lake prospect. See Figure 3 for photograph locations. A) Massive and brecciated, quartz-veined and sericite+pyrite± arsenopyrite-mineralized monzogranite structurally overlies mylonitic monzogranite having fabric-parallel, sulphide-poor, internally deformed quartz veins. The $2 coin is 28 mm in diameter; B) Pink-orange, fine- to medium-grained monzogranite cut by numerous anastomosing irregular sulphidic fractures and narrow quartz veins; C) Fine-grained, pink-orange monzogranite with abundant rusty planar fractures. Note the irregular, pinch and swell, grey translucent quartz vein and sulphide patches in the matrix. Py - pyrite; Apy - arsenopyrite; Qtz - quartz.*

orange–pink–yellow tint to exposed surfaces of mineralized granitoid. Collectively, these quartz veins and fractures exhibit dominant northeast-trending, steeply dipping orientations, although the veins appear to be more variable. The relationship between fracture development, veining and mineralization is not known, but sulphides are typically more common in veins and in thin fractures than as disseminations in the monzogranite. The veins display at least two distinct generations. Early veins are barren, exhibit internal deformation, are commonly foliation parallel and exhibit southeast-trending, southwest-dipping orientations. Late veins cut all ductile deformation fabrics, pinch, swell and anastomose, exhibit extensive marginal wall-rock alteration, contain sulphides and trend dominantly northeast. Sulphide fractures also appear to exhibit two distinct orientations, but are dominated by northeast-oriented surfaces with steep dips (van Egmond and Cox, 2005; Figure 3).

Diamond-drillhole data and local regional mapping adds important information on the rock types, their orientations and spatial relationships and the structural setting of the rocks of the prospect enabling a better understanding of the nature of gold mineralization (van Egmond and Cox, 2005; Reid and Myllyaho, 2010). The trench exposures and drillholes record the first unambiguous relationships for the rocks along this portion of the Victoria Lake shear zone and provide a clear cross-section through the mineralized zone. Many of the diamond-drill holes (van Egmond and Cox, 2005; Reid and Myllyaho, 2010) intersected interlayered packages of variably deformed granite, 'gneiss', chlorite schist and finely bedded grey-black shale and siltstone. Anomalous gold occurs sporadically throughout the upper and middle parts of the drillholes and is hosted almost exclusively by variably textured, sericitic and pyritic monzogranite. Diamond-drillhole ST09-007 (azimuth/dip: 040/45°: Reid and Myllyaho, 2010) intersected two separate mineralized zones and was therefore examined in detail (Figure 4, Plate 5). Gold assays for analyzed sections of the drillhole ranged from <5 – 3123 ppb Au in ~1-m-long, split core intervals (Reid and Myllyaho, 2010). The most significant Au assays are restricted to orange-pink, silicified+sericitized, pyrite±arsenopyrite-bearing, variably textured monzogranite (Figure 4). The upper and lower contacts of the monzogranite horizons also commonly yield high Au assays. Strongly deformed biotitic paragneiss, shale, mudstone and chlorite schist exposed immediately above and below the

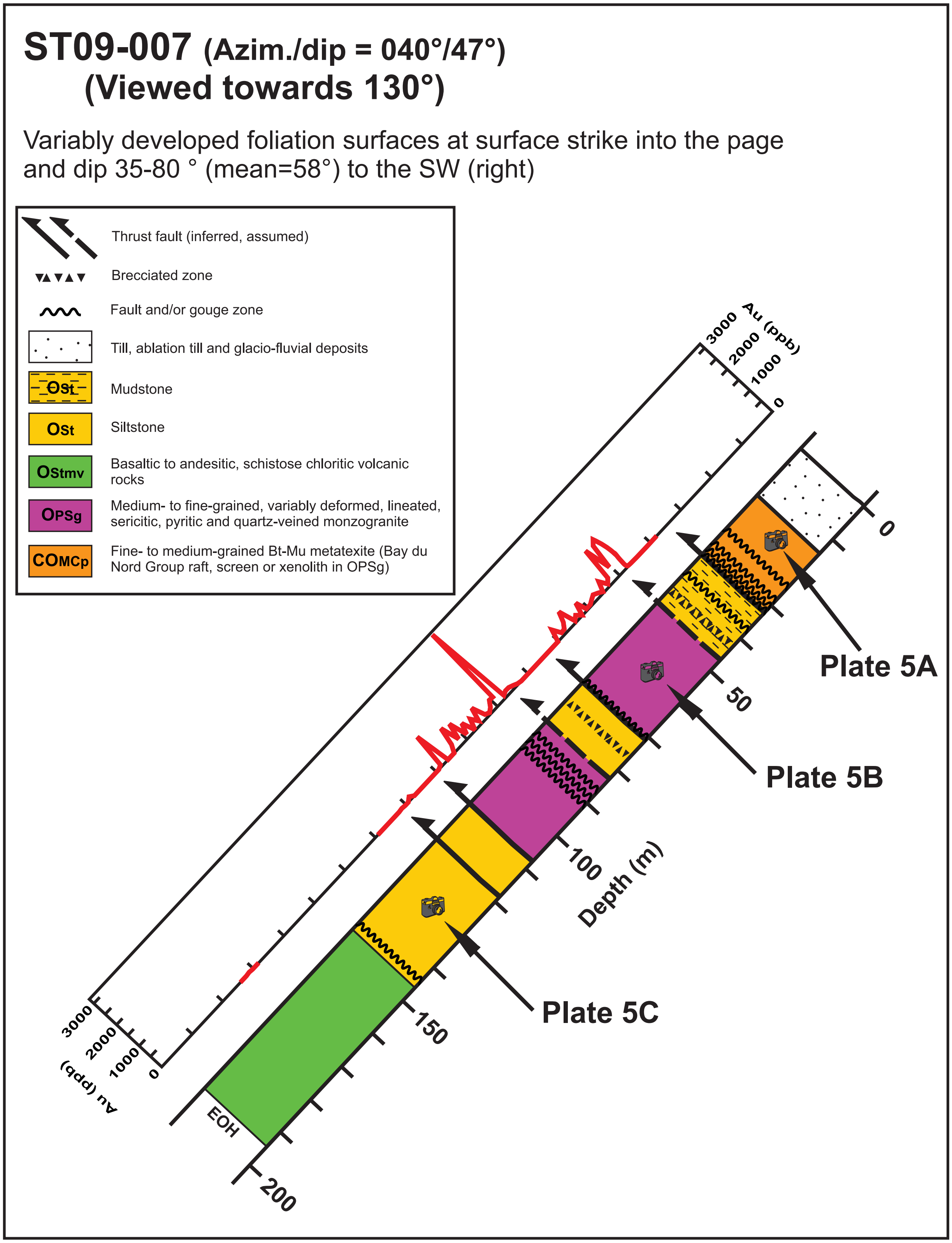


Figure 4. *Schematic stratigraphic log for diamond-drill hole ST09-007 (Reid and Myllyaho, 2010) showing downhole variations in lithology, gold assay values for 0.5- to 1.5-m core lengths and the repetition of mineralized monzogranite. Higher grade gold intercepts invariably occur at the upper and lower contact zones of the granitoid packages. Note the approximate locations of Plates 5A, B and C.*

Plate 5. *Representative photographs of the dominant rock units exposed in diamond-drill hole ST09-007. A) Weakly developed gneissose layering with leucosome in amphibolite-facies-grade Bay du Nord Group biotitic, semipelitic paragneiss. This section of drillcore was not analyzed, but similar rock from other drillholes yielded <5 ppb Au (Reid and Myllyaho, 2010); B) Mylonite, brecciated mylonite and brecciated massive examples of mineralized monzogranite. Material such as this yielded up to 3123 ppb Au; C) Strongly deformed, millimetre-scale bedded, grey siltstone and mudstone structurally below the mineralized monzogranite. Although this particular section was not analyzed, twelve 1-m-split core samples from the top of the siltstone unit yielded ≤109 ppb Au.*

altered granitoid horizons yielded assays ranging from <5 to 1007 ppb Au. Most of these yielded assays significantly <100 ppb Au. Other elements were not analyzed, however, earlier multi-element ICP data for historic auriferous trench, float and drillhole intersections (van Egmond and Cox, 2005) were interpreted to indicate that gold was strongly correlated with arsenic and bismuth, and perhaps weakly correlated with Cu, Pb and Zn.

Drillhole ST09-007 (Figures 2 and 4) was collared in 14.8 m of undivided till and glacio-fluvial sediments. Below this, is 13 m of grey-black, biotite-rich, fine- to medium-grained semipelitic paragneiss having abundant millimetre- to centimetre-scale, foliation-parallel wisps and lenses of intergrown quartz and alkali feldspar (leucosome: Plate 5A). This rock type was not assayed in drillhole ST09-007; however, the few samples from other drillholes were not highly anomalous in gold (only one analysis was >100 ppb). The base of the biotite paragneiss consists of a 2.28-m-wide zone of fault gouge, that passes downward into 16.5 m of green-grey, millimetre-scale bedded mudstone. The lower 8 m of mudstone yielded assays of <5 ppb Au. Along its base, the mudstone is in fault contact with altered and mineralized monzogranite. This upper granitoid horizon is 23.2 m thick and consists of massive, mylonitic and brecciated (texturally variable), quartz-veined and sericite–pyrite±arsenopyrite-altered, pink-orange monzogranite (Plate 5B). This unit is identical in all respects to the mineralized monzogranite exposed in the trench and yielded assays ranging from <5 to 1421 ppb Au.

The base of the upper monzogranite horizon is defined by a 1-m-wide fault zone, and below this is 11.73 m of monotonous, millimetre- to centimetre-scale bedded, strongly foliated and locally crenulated, grey-green siltstone and mudstone. These rocks contained no anomalous gold (<5 ppb). Below this is a second, 26.19-m-thick, structurally lower horizon of variably textured, orange-pink monzogranite that is similarly cut by numerous sulphide fractures and irregular quartz veins. The upper contact with the siltstone is diffuse, brecciated, contains gouge and is likely a fault. This second monzogranite horizon is itself internally cut by a 5-m-wide gouge zone interpreted as a fault. Assay values from this unit ranged from <5 to 3123 ppb Au.

The basal contact of the lower monzogranite consists of 3 m of mixed monzogranite and sedimentary material that is broken and brecciated and is likely a fault. Below this is

36.48 m of very fine-grained, centimetre-scale bedded, locally strongly cleaved, grey-black mudstone and siltstone (Plate 5C). These rocks are described as being locally cut by narrow (≤30 cm) quartz–feldspar-porphyry dykes that may represent Peter Strides monzogranite. The top 20.68 m of these mudstones and siltstones yielded assay results of <5 to 109 ppb Au. The remainder of the drillhole consists of 48.7 m of green-grey, aphanitic, moderately foliated chlorite schist interpreted to represent the mafic volcanic member of the Storm Brook Formation. Seven, 67-cm- to 1-m-split core assays from this unit yielded only one anomalous result of 22 ppb Au.

LITHOGEOCHEMISTRY

ANALYTICAL METHODS

Twenty three samples of granodiorite to monzogranite were collected from regional, non-mineralized as well as mineralized localities. Seven representative samples of mafic volcanic schists, one from the Pine Falls Formation (OPF) and six from the Storm Brook Formation (Unit OSTmv) were also collected to investigate the rocks immediately adjacent to the South Wood Lake gold prospect mineralization. These were all submitted for determination of their major-, trace-, rare-earth element (REE) and gold pathfinder-element contents. Samples were analyzed at the Department of Natural Resources, Government of Newfoundland and Labrador, Geochemical Laboratory (Howley Building, Higgins Line) for their major and selected trace elements. Analytical methods for these elements are after Finch (1998). Some of the samples were analyzed for REE and other selected elements by ICP-MS, total digestion methods at XRAL Laboratories in Ancaster, Ontario, using standard methods outlined on their website (http://www.actlabs.com/). The Au, Cd, Bi, As and Sb were determined *via* Instrumental Neutron Activation Analysis (INAA) at Becquerel Laboratories (http://www.becquerellabs.com/). (Representative results are available from H.A. Sandeman, unpublished data, 2014). These new data are supplemented, where applicable, with exploration company lithogeochemical data (van Egmond *et al.*, 2003; van Egmond, 2004; van Egmond and Cox, 2005; Reid, 2009) for evaluation of inter-element variations associated with mineralization.

LITHOGEOCHEMICAL RESULTS

Unaltered biotite±muscovite granitoid rocks constituting regional exposures of the Peter Strides monzogranite to granodiorite (Unit OPSg: van Staal *et al.*, 2005) are granodiorite and tonalite in the molecular normative classification scheme of Streckeisen and Le Maitre (1979; Figure 5A), and granodiorite, tonalite and trondhjemite in the molecular normative plot of Barker (1979; Figure 5B). The granitoid rocks that host gold mineralization at the South

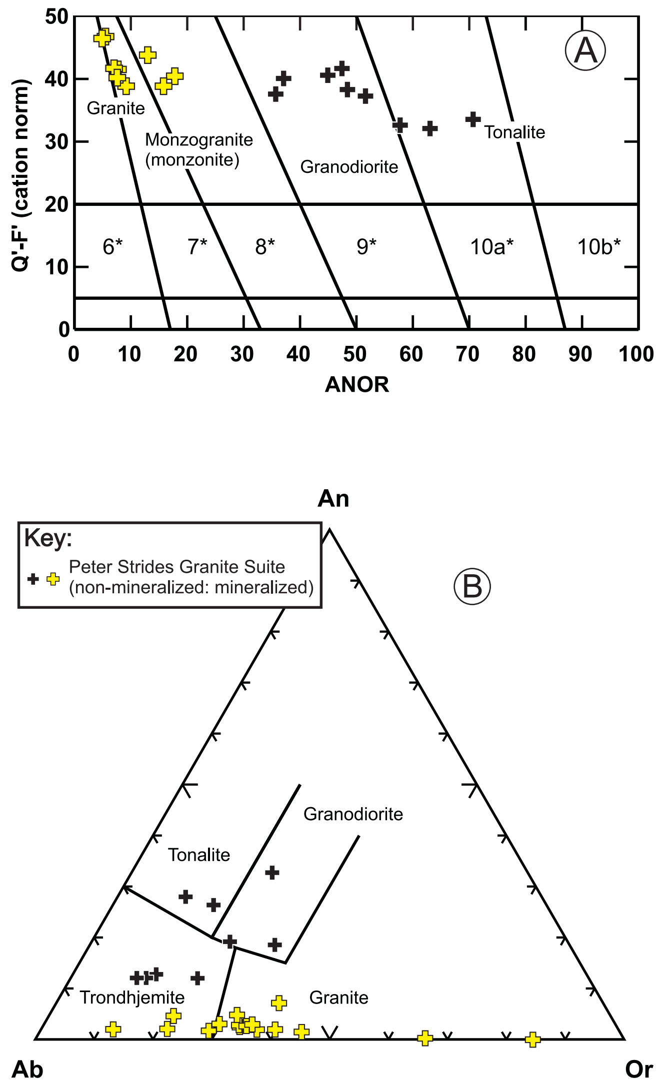
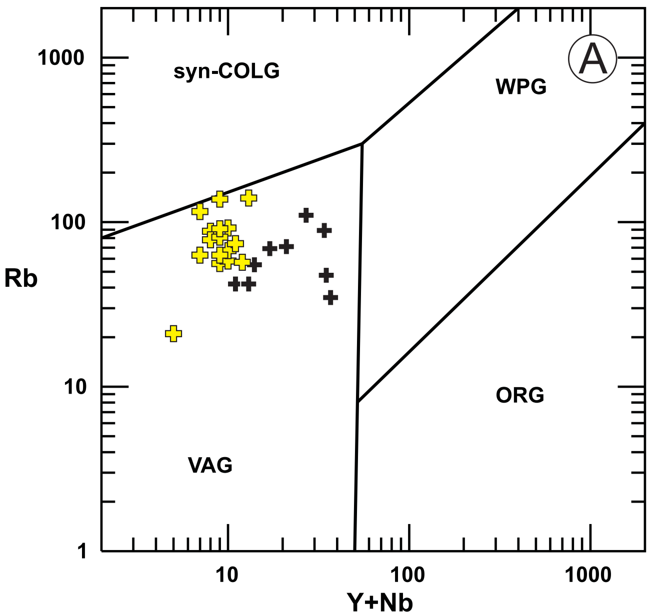


Figure 5. *Classification of granitoid rocks. A) Molecular normative QAPF diagram (after Streckeisen and Le Maitre, 1979); B) CIPW normative classification diagram of Barker (1979).*

Wood Lake gold prospect, the Sure Shot showing and the Hilltop showing, are monzogranite in the molecular normative classification scheme of Strekeisen and Le Maitre (1979; Figure 5A) and trondhjemite varying to granite in the molecular normative plot of Barker (1979; Figure 5B). All granitoids exhibit Nb, Y and other high-field strength abundances characteristic of volcanic-arc granitoids (Figure 6A, B; after Pearce *et al.*, 1984) although it is clear that mineralized samples have lower Y but comparable Nb abundances to non-mineralized samples. In Figure 7, all granitoid samples are plotted in an extended rare-earth-element, or multi-element plot where it is clear that all of the granitoid rocks, both mineralized and non-mineralized, exhibit very similar multi-element patterns. This strongly suggests a shared petrogenesis. Mineralized and non-mineralized samples may,



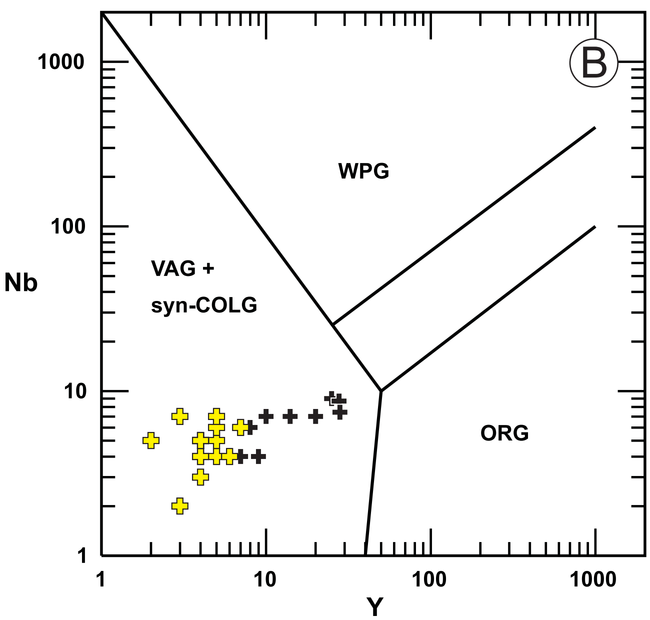


Figure 6. *A) Rb* versus *Y+Nb tectonic discrimination plot; B) Nb* versus *Y tectonic discrimination plot for granitoid rocks (both after Pearce* et al.*, 1984). Symbols as in Figure 5.*

however, be systematically distinguished in terms of their abundances of major and incompatible trace elements. Mineralized granitoids have lower MgO, FeO^T, CaO, MnO, P_2O_5 and TiO_2, higher SiO_2 and typically elevated K_2O relative to non-mineralized rocks. Mineralized granites also have lower abundances of the high-field strength elements (HFSE) P, Zr, Hf and Ti, Eu, Y and the heavy-rare-earth elements (HREE) than non-mineralized granitoids (Figures 5, 6 and 7).

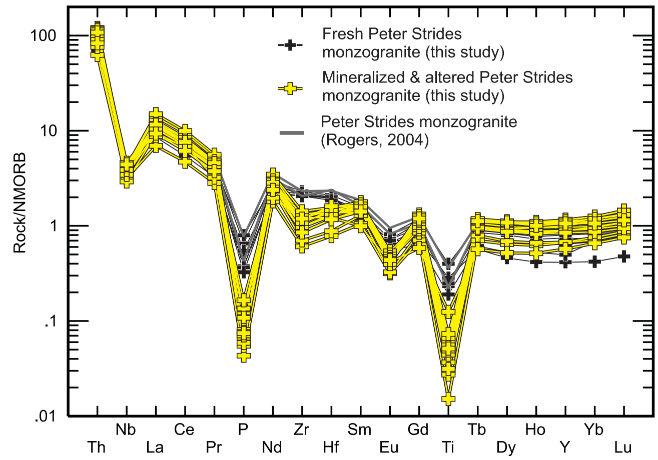


Figure 7. *Multi-element plot for granitoid rocks of the study area. N-MORB normalization values are from Sun and McDonough (1989).*

Basaltic rocks exposed proximal to the South Wood Lake gold prospect dominantly consist of chlorite schist (mafic volcanic rocks) of the Storm Brook Formation; one fine-grained gabbro, however, is from what is mapped on a regional scale as the Pine Falls Formation (HS10-52). All are basalts to basaltic trachy andesites in the TAS diagram (Le Bas and Streckeisen, 1991; Figure 8A) and are basalt to alkali basalt in the incompatible trace-element diagram of Pearce (1996; Figure 8B). They plot as E-MORB varying to arc basalts in the Th–Zr–Nb diagram of Wood *et al.* (1979; Figure 8C). All of these mafic rocks appear to be compositionally similar to E-MORB, very much like basaltic rocks of the Storm Brook Formation, but unlike the N-MORB to arc-basalt compositions published for the Pine Falls Formation (Evans and Kean, 2002; Rogers, 2004; Valverde-Vaquero *et al.*, 2006).

In Figure 9, it is clear that the multi-element pattern for sample HS10-52 has a convex-downward, light-REE-enriched pattern with a peak at Nb. This is distinct from an array of arc-like multi-element patterns, with variable negative Nb anomalies, for representative basaltic rocks of the Pine Falls Formation (Evans and Kean, 2002; Rogers, 2004). Moreover, it is clear from comparison of Figures 9A and B, that the multi-element pattern for sample HS10-52 displays more similarity with basaltic rocks of the Storm Brook Formation than those of the Pine Falls Formation (Rogers, 2004; van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). All basalt samples collected during the present study have variably LREE-enriched patterns. They also exhibit variable Th–Nb–La relationships where five of seven have negligible to positive Nb anomalies but the other two have minor and moderate negative Nb anomalies. The former appear to be enriched, tholeiitic to alkali E-MORB basalts, whereas the latter exhibit arc-type compositions.

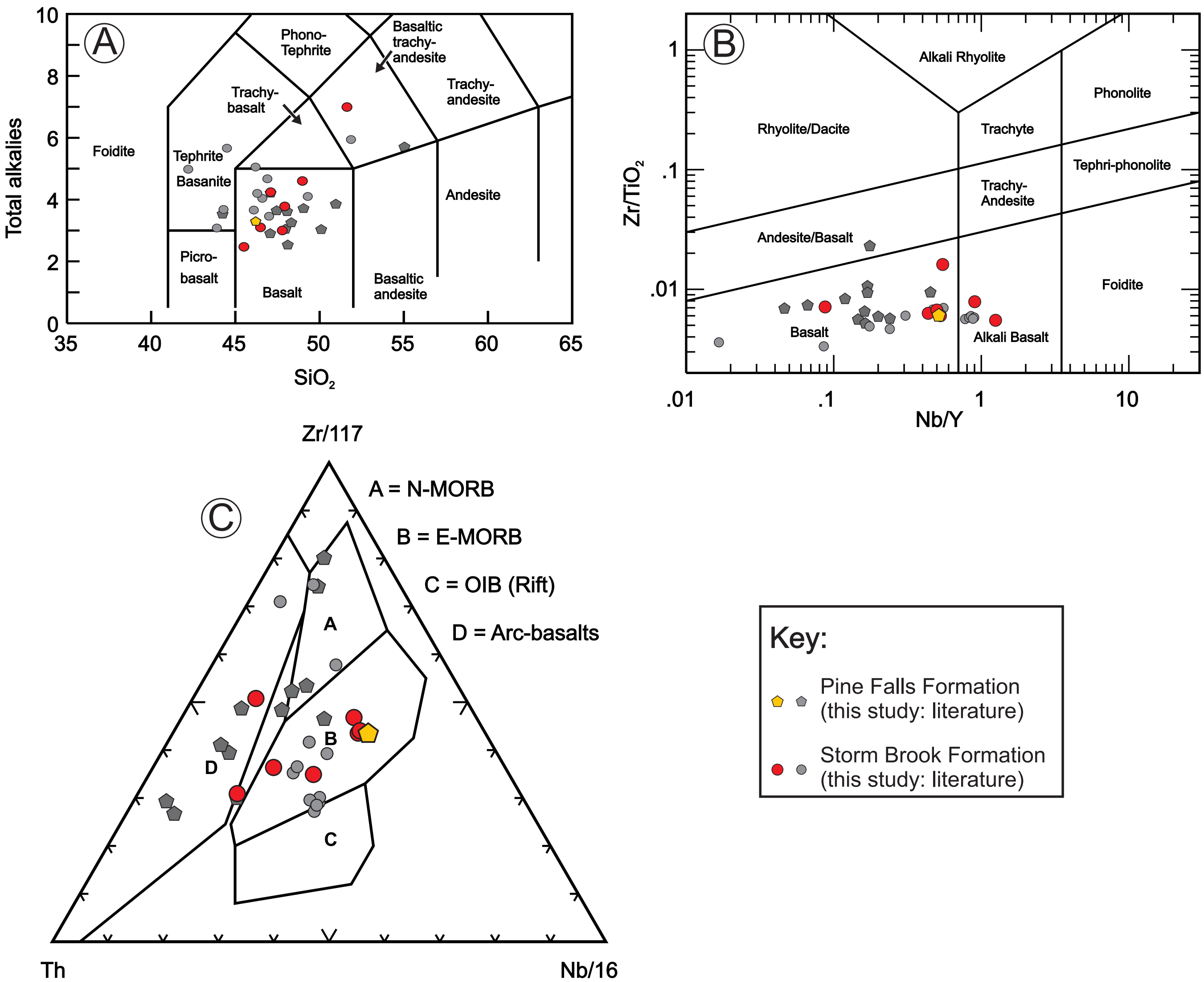


Figure 8. *Classification of chlorite schist of the Storm Brook and Pine Falls formations of the Red Cross Group. A) Total alkalies* versus *SiO_2 diagram (after LeBas and Streckeisen, 1991); B) Zr/TiO_2* versus *Nb/Y (after Pearce, 1996); C) Th–Zr–Nb tectonic discrimination plot (after Wood* et al.*, 1979).*

In Figure 10A through 10E, exploration multi-element ICP rock data along with research-grade lithogeochemical data from the present study are examined in logarithmic plots to better understand the elemental and mineralogical controls on anomalous gold concentrations. Figure 10A shows a plot of As (ppm) *versus* Au (ppb). Mineralized granitoid rocks of the South Wood Lake gold prospect and the Hilltop and Sure Shot showings are strongly enriched in arsenic, up to 100 000 times average crustal concentrations (Rudnick and Gao, 2003). It is readily apparent that a strong relationship exists between the presence of gold and an abundance of arsenic. However, it is important to note that many altered granitoid rocks exhibit arsenic concentrations up to 1000 times the crustal average, even though gold is not enriched. Figure 10B shows a plot of Bi (ppm) *versus* Au (ppb). Although Bi is not as strongly enriched as gold, many gold-mineralized samples also contain elevated Bi, up to 150 times the crustal average (Rudnick and Gao, 2003). In non-mineralized samples, Bi is at or below a detection limit of 0.1 ppm (Figure 10B). Similar, though perhaps less-convincing relationships, are observed between gold and the elements cadmium (Cd), antimony (Sb) and silver (Ag: Figures 10C, D & F). Tellurium (not shown) also appears to have a positive correlation with gold (van Egmond and Cox, 2005), however, tellurium and many of these pathfinder elements are notoriously difficult to analyze at low ~1 ppm, normal crustal concentration levels (*see* for example: http://www.sgs.com/en/Mining/Analytical-Services/Chemical-Testing/Trace-Elements/Hydride-Elements.aspx). Lead (Pb), zinc (Zn) and copper (Cu) do not appear to correlate

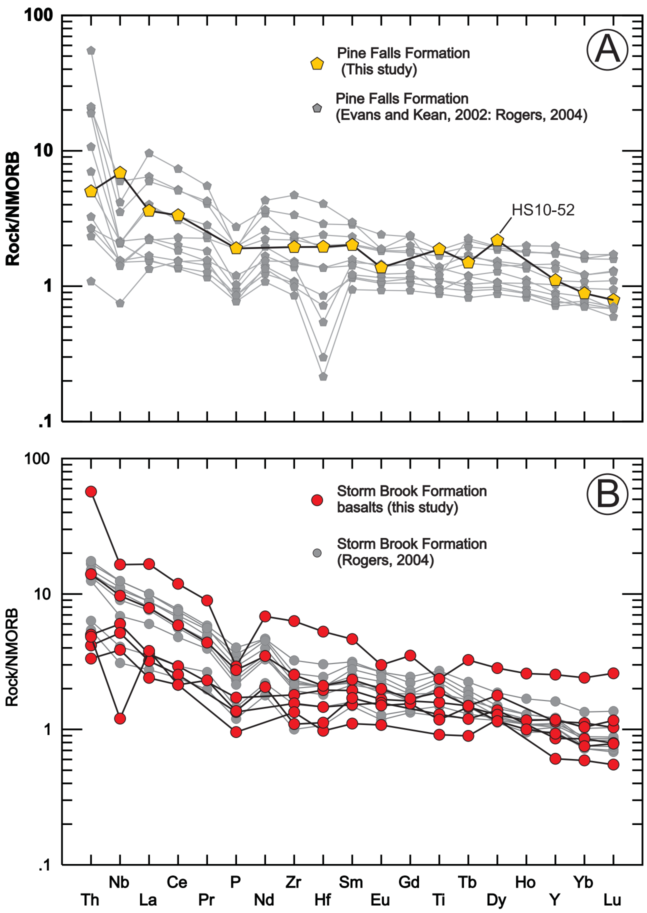


Figure 9. *Multi-element plots for basaltic rocks of the South Wood Lake prospect area. (A) Fine-grained gabbro sample HS10-52 compared to literature data for the basaltic rocks of the Pine Falls Formation; (B) six samples of chlorite schist compared to comparable data for the Storm Brook Formation (data from Evans and Kean, 2002; Rogers, 2004; Valverde-Vaquero* et al.*, 2006). N-MORB normalization values are from Sun and McDonough (1989).*

with gold and are present only at normal crustal concentrations (≤150 ppm) even with corresponding gold concentrations up to 8000 ppb.

PRELIMINARY PETROGRAPHIC ANALYSIS

Granitoid rocks from the Main trench exhibit weak to intense sericitization that is accompanied by albitization of feldspars and the precipitation of euhedral to subhedral quartz in irregular, typically anastomosing narrow veinlets (Plate 6A, B). Alteration phases do not exhibit any preferred orientation and appear to be entirely undeformed. Euhedral to subhedral pyrite and arsenopyrite occur disseminated throughout the groundmass of altered monzogranite, but are typically more abundant in and along the margins of quartz veins (Plate 6C, D). Siderite commonly forms mantles (Plate 7A) on, or entirely replaces, pyrite. Bournonite ($PbCuSbS_3$) forms thin films on, or locally forms tiny blebs in euhedral pyrite (Plates 6D and 7C). Tiny native gold grains (<10μm) and small Bi-tellurides (<20μm) were noted in a vein and vein margin, respectively (Plate 7B, C).

IMPLICATIONS OF THE DATA

New mapping, lithogeochemical and petrographic studies, in conjunction with diverse mineral-exploration industry data including ground magnetic and induced polarization studies, regional prospecting and trenching, and diamond-drillhole intersections, reveal important new information on the rock types, their gross orientations and their interrelationships in the area around the South Wood Lake gold prospect of the Staghorn exploration property. These observations have regional significance as the prospect occurs in the Victoria Lake shear zone, consisting of a series of moderately south-dipping, reverse faults (thrust zone), with fault-bounded panels, and separating the granitoid and metasedimentary rocks of the Meelpaeg Subzone (Gander Zone) to the south, from the greenschist-facies-grade, volcanic and sedimentary rocks of the Red Cross Group of the Exploits Subzone to the north (van Staal *et al.*, 2005; Valverde-Vaquero *et al.,* 2006).

Chlorite schist in the immediate vicinity of the South Wood Lake gold prospect is E-MORB tholeiitic basalt varying to alkali basalt and less common arc-like basalt with variable Nb troughs. These best correlate with basaltic rocks of the Storm Brook Formation of the Red Cross Group. The presence of basaltic rocks, comparable in composition to those of the Pine Falls Formation, cannot be unambiguously demonstrated and may indicate that the unit has been cut out of the tectonostratigraphy in the King George IV map area.

The South Wood Lake gold prospect as well as the Sure Shot and Hilltop gold showings are hosted by variably deformed granodioritic to monzogranitic rocks that, on the basis of lithogeochemical evidence, appear to all represent petrochemically similar components of the Peter Strides granite suite (Unit OPSg, Figure 2: van Staal *et al.*, 2005). In the uppermost sections of drillholes at the South Wood Lake gold prospect, Bay du Nord metasedimentary rocks are structurally imbricated with quartz-veined, sericite+albite+pyrite+hematite±arsenopyrite-altered Peter Stride granodiorite (now monzogranite). The monzogranite contains schlieren, xenoliths, screens and rafts of Bay du Nord metasedimentary rocks. In deeper parts of the drillholes, rock types are dominated by thick panels of interlayered, strongly schistose, fine-grained clastic metasedimentary and metavolcanic rocks of the Storm Brook Formation (van Egmond and Cox, 2005; van Staal *et al.*, 2005; Reid and Myllyaho, 2010). The presence of structural repetition of

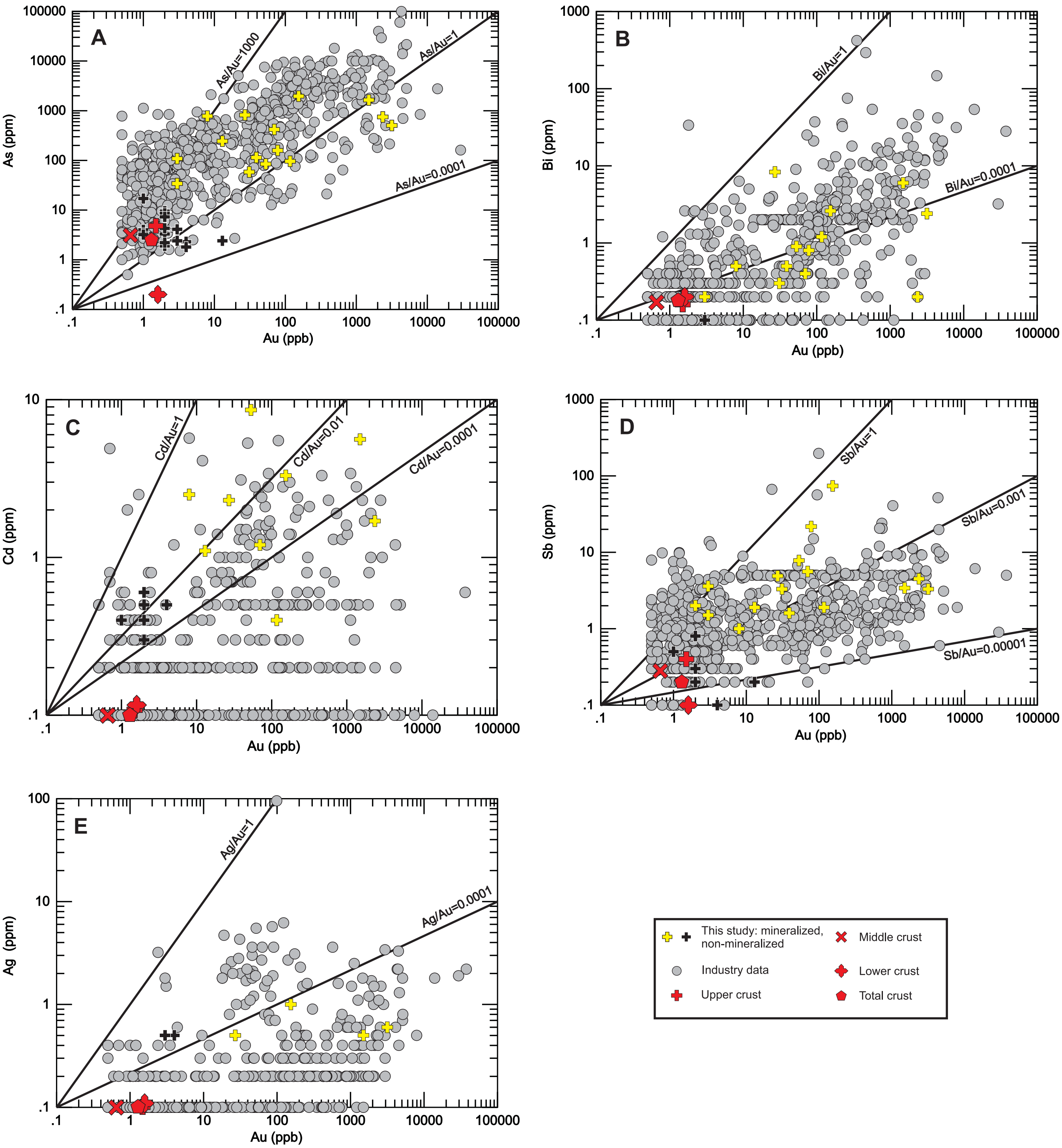


Figure 10. *Log-log plots of selected elements versus gold for rocks of the South Wood Lake gold prospect as well as non-mineralized rocks of the area. A) As* versus *Au; B) Bi* versus *Au; C) Cd* versus *Au; D) Sb* versus *Au; E) Ag* versus *Au. Also shown are average upper, middle, lower and bulk crustal values from Rudnick and Gao (2003).*

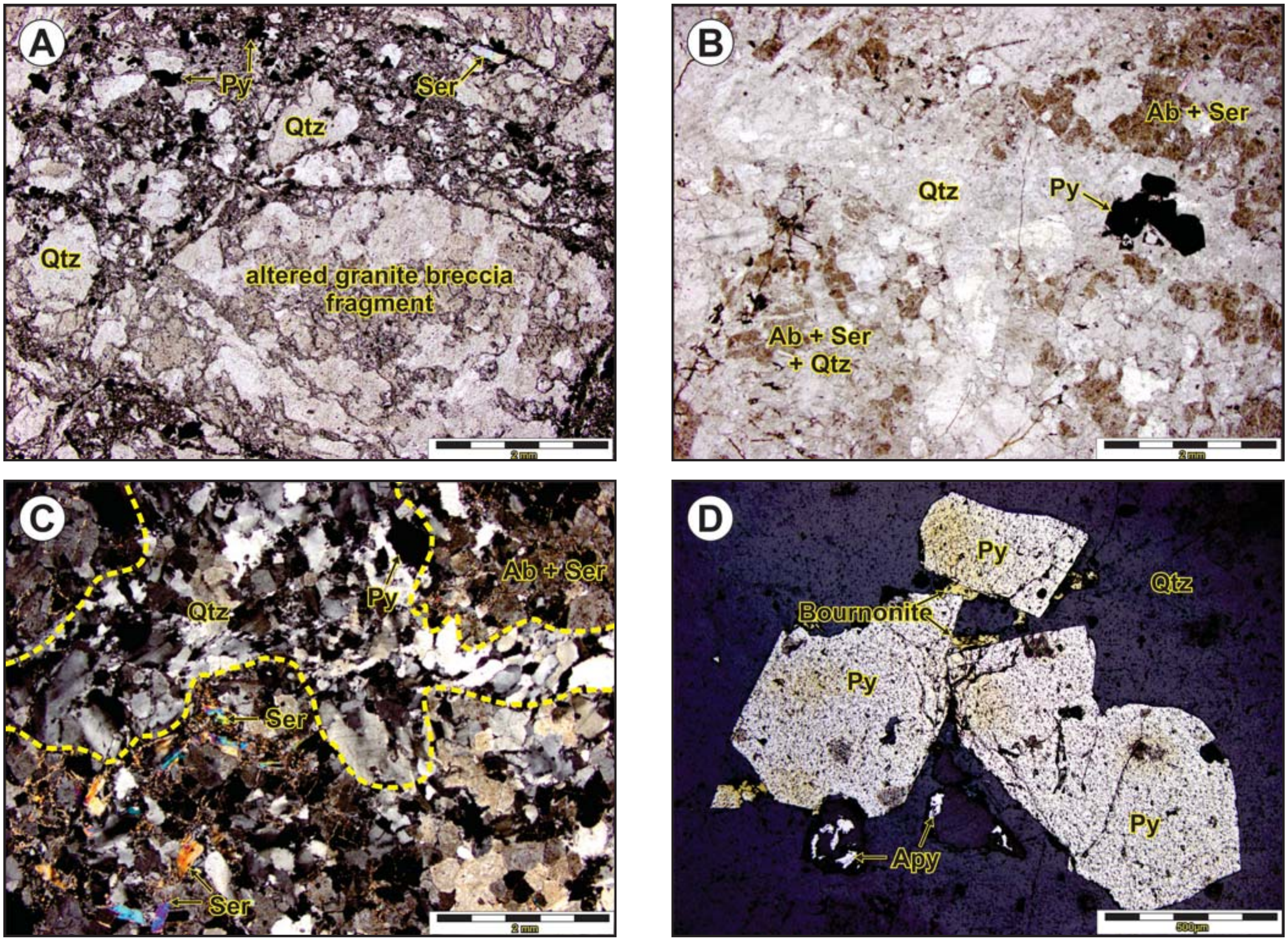
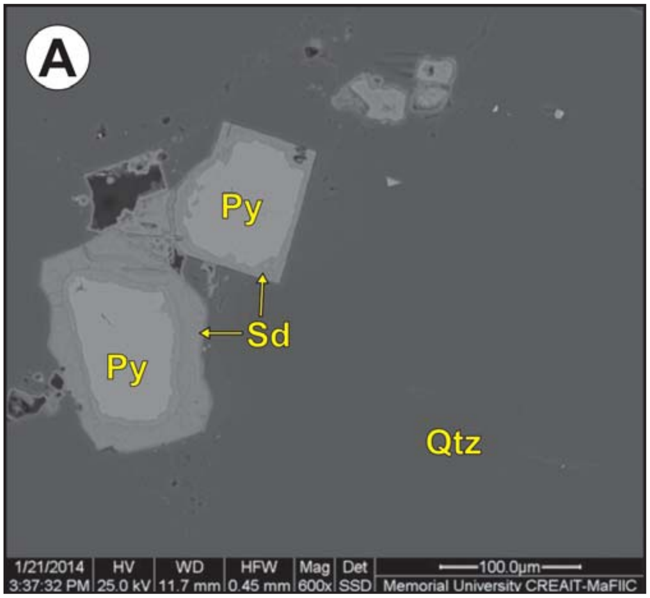
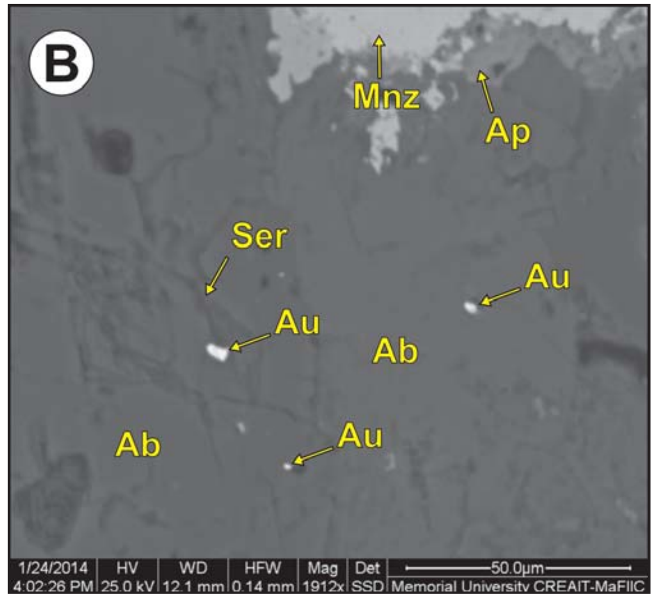


Plate 6. *Representative photomicrographs of mineralization from sample HS10-31B (3170 ppb Au; 2.4 ppm Bi; 2.9 ppm Sb). A) Brecciated, sericite–albite–pyrite-altered monzogranite in plane-polarized light; B) Anastamosing, diffuse quartz veins with subhedral pyrite cuts albite–sericite–quartz-altered monzogranite and siderite–limonite(?) fractures,. Note that the siderite fractures also cut the quartz vein; C) Euhedral pyrite and subhedral arsenopyrite occur in a diffuse, anastamosing quartz vein hosted by albite+sericite+quqrtz-altered monzogranite; D) Subhedral arsenopyrite and euhedral pyrite in vein quartz (*see *Plate 6C). Note the film-like coatings of bournonite ($PbCuSbS_3$) on the pyrite grains. Mineral abbreviations after Kretz (1983). Py - pyrite; Apy - arsenopyrite; Qtz - quartz; Ser - sericite; Ab - albite.*

altered and mineralized monzogranite in some drillholes (*e.g.*, ST09-007), indicate that the subzone boundary along the Victoria Lake shear zone preserves a series of structurally imbricated, variably deformed units of both the Meelpaeg and Exploits subzones. These macroscopically interlayered rocks are separated by gouge and discordant breccia zones that are interpreted as faults. These observations suggest that the faults and lithologically distinct slices represent klippe, bounded by moderately south-dipping fault surfaces. The southeast-trending mylonitic fabric in mineralized granitoid trench exposures may, therefore, represent an early fabric developed during ductile stacking of the Meelpaeg Subzone on to the Exploits Subzone during Salinic Silurian orogenesis. The variation in the orientation of the main penetrative fabric in the rocks of the area, from northeast-trending to the west of the prospect, to southeast-trending at the prospect back to northeast-trending near the Hilltop showing, suggests that subzone boundary, the Victoria Lake shear zone, and the contained imbricate panels form an approximately 1 km wavelength, open, south-southwest-plunging z-fold.

Mineralization clearly postdates mylonitization and perhaps also structural imbrication as it does not exhibit deformation. It is essentially entirely confined to the rheologically brittle, imbricate panels of Peter Strides granodiorite preserved in the hanging wall of the basal (?) Victoria Lake shear zone thrust fault. Alteration and sulphide-bearing quartz veins are typically absent in gneissose, sedimentary and volcanic rocks encountered in the diamond-drillholes. Mineralization consists of widespread, narrow (≤10 cm),





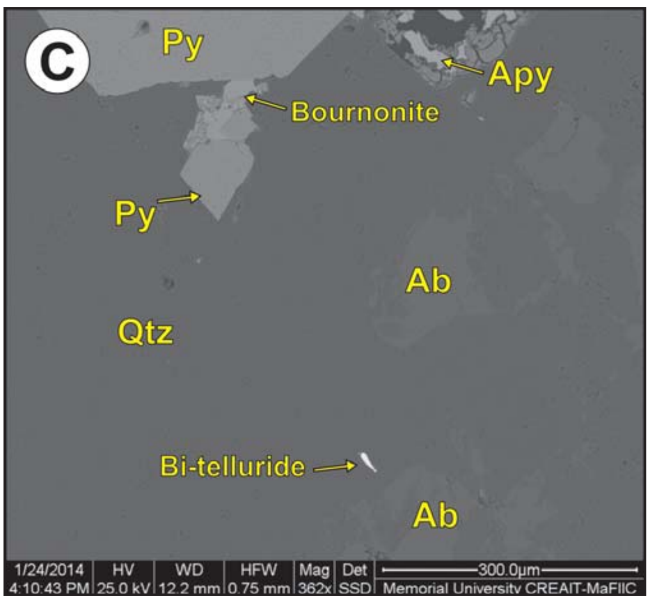


Plate 7. *Backscatter electron images of mineralization (HS10-31B). A) Siderite mantles euhedral pyrite in a quartz vein; B) Tiny native gold grains (<10 μm) along with monazite and apatite set in a matrix of albite and quartz; C) Small (<20μm) Bi-telluride grain hosted by vein quartz. Key: Py - pyrite; Apy - arsenopyrite; Qtz - quartz; Ab - albite; Sd - siderite; Ser - sericite; Ap - apatite; Mnz - monazite; Au - gold.*

typically anastomosing pinch-and-swell quartz veins and stockworks and local silica flooding, accompanied by albitization of feldspars, sparse, fine- and coarse-grained disseminated pyrite (≤5%), less-common subhedral arsenopyrite and sparse, disseminated and fracture controlled fine-grained white mica in vein haloes. Pyrite is widely replaced by paragenetically late hematite and siderite, which lends an orange-pink-yellow hue to mineralized granitoid rock. Quartz-veined monzogranite having extensive replacement of its matrix by albite+sericite+silica+pyrite and cut by numerous sulphide-hematite fractures typically carries the highest gold, arsenic, antimony, bismuth and cadmium assays. Gold is strongly correlated with arsenic, and less so with bismuth, antimony, cadmium and perhaps silver and tellurium. Fine-grained gold has been panned from glacial materials that directly overlie exposed bedrock and is reported in a number of industry reports (van Egmond *et al.*, 2003; van Egmond, 2004; van Egmond and Cox, 2005). In thin section, native gold occurs as tiny grains (<10 μm) associated with albite+sericite alteration in the margin of veins. Bi-tellurides (<20 μm) were were also noted in a quartz vein in association with pyrite and arsenopyrite. Bournonite ($PbCuSbS_3$) forms thin films on euhedral pyrite, particularly those located in quartz veins.

The new lithogeochemical data for the granitoid rocks of this investigation demonstrate that the South Wood Lake gold prospect is hosted by the 467 ± 6 Ma Peter Strides monzogranite (van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). The maximum age of the mineralization at the

South Wood Lake gold prospect is, therefore, 473 Ma (van Staal *et al.*, 2005; Valverde-Vaquero *et al.*, 2006). Its minimum age, however, is presently unconstrained. The posttectonic character of the gold mineralization at the South Wood Lake gold prospect, as well as the spatial association of the mineralized zone with a southwest-plunging z-assymetric flexure of the Victoria Lake fault zone, suggests that the mineralization is of Late Silurian or likely Devonian age. The $^{40}Ar–^{39}Ar$ thermochronology on randomly oriented, fine-grained sericite deposited with quartz, pyrite, arsenopyrite and gold in the South Wood Lake zone will help constrain the minimum age of the mineralization.

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