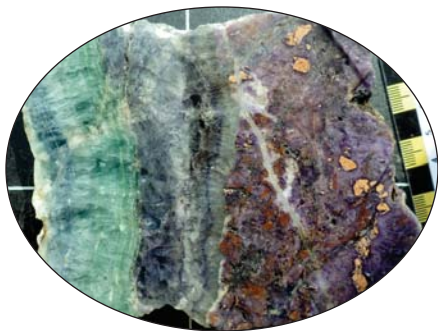


**GAC NL 2018 FALL FIELDTRIP**

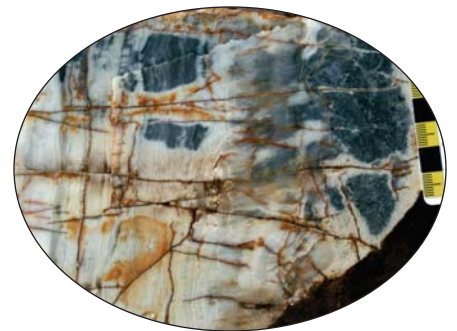
**MINERAL DEPOSITS OF THE BURIN  
PENINSULA**

**SEPTEMBER 21ST TO 23RD, 2018**

**OPEN FILE NFLD/3338**



**GAC**  
Newfoundland  
and Labrador



Zsuzsanna Magyarosi, Graham Layne  
and Greg Sparkes

**GEOLOGICAL ASSOCIATION OF CANADA  
NEWFOUNDLAND AND LABRADOR SECTION**

**FALL FIELD TRIP FOR 2018  
(September 21 to September 23)**

**Mineral Deposits of the Burin Peninsula**

**Field Trip Guide and Background Material**

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**September, 2018**



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James Conliffe, Joanne Rooney and Chris Pereira are thanked for help with editing and producing this guidebook.

# **SAFETY INFORMATION**

## **General Information**

The Geological Association of Canada (GAC) recognizes that its field trips may involve hazards to the leaders and participants. It is the policy of the Geological Association of Canada to provide for the safety of participants during field trips, and to take every precaution, reasonable in the circumstances, to ensure that field trips are run with due regard for the safety of leaders and participants. GAC recommends steel-toed safety boots when working around road cuts, cliffs, or other locations where there is a potential hazard from falling objects. GAC will not supply safety boots to participants. Some field trip stops require sturdy hiking boots for safety. Field trip leaders are responsible for identifying any such stops, making participants aware well in advance that such footwear is required for the stop, and ensuring that participants do not go into areas for which their footwear is inadequate for safety. Field trip leaders should notify participants if some stops will require waterproof footwear.

Field trip participants are responsible for acting in a manner that is safe for themselves and their co-participants. This responsibility includes using personal protective equipment (PPE) when necessary (when recommended by the field trip leader or upon personal identification of a hazard requiring PPE use). It also includes informing the field trip leaders of any matters of which they have knowledge that may affect their health and safety or that of co-participants. Field Trip participants should pay close attention to instructions from the trip leaders and GAC representatives at all field trip stops. Specific dangers and precautions will be reiterated at individual localities.

## **Specific Hazards**

Some stops on this field trip are in coastal localities. Access to the coastal sections normally requires short hikes, in some cases over rough, stony or wet terrain. There is a strong possibility that participants will get their feet wet, and we recommend waterproof footwear. We also recommend footwear that provides sturdy ankle support, as localities may also involve traversing across beach boulders or uneven rock surfaces. Coastal localities present some specific hazards, and participants **MUST** behave appropriately for the safety of all. Participants must stay clear of the cliff edges at all times, stay with the field trip group, and follow instructions from leaders. Please stay away from any overhanging cliffs or steep faces, and do not hammer any locations immediately beneath the cliffs. In all coastal localities, participants

must keep a safe distance from the ocean, and be aware of the magnitude and reach of ocean waves. If it is necessary to ascend from the shoreline, avoid unconsolidated material, and be aware that other participants may be below you. Take care descending to the shoreline from above.

Other field trip stops are located on or adjacent to roads. Participants should make sure that they stay off the roads, and pay careful attention to traffic, which may be distracted by the field trip group. Roadcut outcrops present hazards from loose material, and should be treated with the same caution as coastal cliffs. Other outcrops may be in disused quarries or excavations, or may require short hikes from roads across possibly uneven and/or wet terrain. Weather is unpredictable in this area and participants should be prepared for a wide range of temperatures and conditions. Always take suitable clothing. A rain suit, sweater, sturdy footwear are essential at almost any time of the year.

The hammering of rock outcrops, which is in most cases completely unnecessary, represents a significant “flying debris” hazard to the perpetrator and other participants. For this reason, we ask that outcrops not be assaulted in this way; if you have a genuine reason to collect a sample, inform the leaders, and then make sure that you do so safely and with concern for others. The trip visits some outcrops that have unusual features, and these should be preserved for future visitors. Frankly, our preference is that you leave hammers at home or in the field trip vans.

Subsequent sections of this guidebook contain the stop descriptions and outcrop information for the field trip. In addition to the general precautions and hazards noted above, the introductions for specific localities make note of specific safety concerns such as traffic, water, cliffs or loose ground. Field trip participants must read these cautions carefully and take appropriate precautions for their own safety and the safety of others.



# INTRODUCTION

The western portion of the Avalon Zone of Newfoundland is host to several well-preserved examples of hydrothermal-related mineralization. The two main styles of mineralization that will be the focus of this trip will be the Neoproterozoic epithermal-related mineralization developed within the arc-related volcanic sequence, and the hydrothermal vein-hosted fluorite mineralization associated with the emplacement of Devonian intrusive rocks.

The Avalon Zone forms the easternmost portion of the Appalachian orogen in much of North America, and extends from the Carolina Slate Belt in the south, to the Avalon Peninsula of Newfoundland in the north, where it represents the northeastern termination of the orogen (Williams, 1979; O'Brien *et al.*, 1996; O'Brien *et al.*, 1998; Foley and Ayuso, 2012). This zone is characterized by widespread magmatic activity ranging in age from *ca.* 760 – 550 Ma (O'Brien *et al.*, 1996). During this time, magmatic arcs formed within arc and back-arc environments or analogous continental extensional type settings (O'Brien *et al.*, 2001 and references therein). Within the volcanic sequence, high-level intrusions resulted in the formation of large-scale magmatic-hydrothermal systems, which were locally accompanied by precious metal deposition. Most of the epithermal alteration and related mineralization identified in the Avalon Zone is hosted within subaerial volcanic rocks ranging in age from 590–550 Ma. The volcanic rocks are intercalated within thick sequences of marine, deltaic and fluvial siliciclastic sedimentary rocks, which formed within basins of varying dimensions, setting, complexity and age. The deposition of these sedimentary sequences can locally be demonstrated to have played a vital role in the preservation of the underlying epithermal systems through rapid burial (*e.g.* Sparkes *et al.*, 2005).

Following the accretion of the Avalon Zone with Laurentia during the Acadian orogeny in the late Silurian-early Ordovician, Devonian plutons intruded along the western margin of the Avalon Zone. The two most well-known examples of such are represented by the Ackley and the St. Lawrence granites, which have been dated at  $372 \pm 4$  Ma (Kellett *et al.*, 2014) and  $374 \pm 2$  Ma (Kerr *et al.*, 1993b), respectively. The emplacement of the St. Lawrence Granite resulted in the development of significant fluorite mineralization. This mineralization was traditionally only known to be hosted within the granite intrusive rocks, but more recent work has shown the mineralization can also be hosted within the adjacent sedimentary country rocks (Magyarosi, 2018 and references therein).

## Regional Geology of the Western Avalon Zone

The Avalon Zone of Newfoundland is dominated by late Neoproterozoic volcanic and sedimentary rocks, which include several discrete volcanic and sedimentary sequences, ranging in age from ~ 760 Ma to ~ 550 Ma. The rocks of most interest in the context of this excursion are the younger parts of the succession, commencing at ~ 570 Ma. Late Neoproterozoic rocks are in turn overlain by a Cambrian platformal sedimentary cover sequence that marks the cessation of volcanic activity and related epithermal systems within the Avalon Zone (O'Brien *et al.*, 1996 and references therein). The Neoproterozoic rocks, along with the associated Paleozoic cover sequence, are unconformably overlain by late Silurian to early Devonian terrestrial volcanic and associated siliciclastic rocks, preserved within isolated outliers throughout the Burin Peninsula (O'Brien *et al.*, 1995). Within the Avalon Zone of Newfoundland the intensity of Paleozoic deformation broadly increases from east to west toward the Dover and Hermitage Bay faults, which mark the western extent of Avalonian rocks and defines their tectonic contact with the adjacent Gander Zone (Widmer, 1950; Younce, 1970; Blackwood and Kennedy, 1975; Kennedy *et al.*, 1982). The majority of the deformation is attributed to the Devonian Acadian orogeny (Dallmeyer *et al.*, 1983; Dunning *et al.*, 1990; O'Brien *et al.*, 1991; O'Brien *et al.*, 1999; van Staal, 2007); however evidence for older, Precambrian deformational events is also locally preserved (*e.g.* Anderson *et al.*, 1975; O'Brien, 1993; O'Brien *et al.*, 1996; O'Brien, 2002).

Within the western Avalon Zone, epithermal alteration and mineralization is most abundant in volcanic rocks of the ca. 590–570 Ma Marystown Group (Strong *et al.*, 1978a, 1978b; O'Brien *et al.*, 1999). This sequence generally comprises greenschist-facies subaerial flows and related pyroclastic and volcanoclastic rocks ranging in composition from basalt, through andesite and rhyodacite, to rhyolite. The volcanic rocks are of both calc-alkaline and tholeiitic affinity (Hussey, 1979; O'Brien *et al.*, 1990; 1996; 1999). The Marystown Group represents the main core of the Burin Peninsula, forming a broad-scale anticlinorium, which is flanked to the east by a shoaling-upward sequence of marine to terrestrial sedimentary rocks of the Neoproterozoic Musgravetown Group (O'Brien, *et al.*, 1999); volcanic rocks at the base of the Musgravetown Group (Bull Arm Formation) have been locally dated at 570 +5/-3 Ma (O'Brien *et al.*, 1989).

To the west and north, the Marystown Group is overlain by the ca. 570 to 550 Ma Long Harbour Group. The Long Harbour Group is dominated by shallow marine sedimentary rocks and subaerial felsic volcanic rocks of alkaline to peralkaline affinity, along with related clastic rocks, which pass conformably upward into fossiliferous Cambrian sedimentary rocks related to the development of a platformal cover sequence (Williams, 1971; O'Brien, *et al.*, 1984; O'Brien *et al.*, 1995). The Long Harbour Group is divisible into a lower volcanic sequence (Belle Bay Formation) and an upper volcanic sequence (Mooring Cove Formation), which are separated by a clastic sedimentary unit known as the Anderson's Cove Formation (O'Brien *et al.*, 1984).

Rhyolites from both the Belle Bay and Mooring Cove formations have been dated at  $568 \pm 5$  Ma and  $552 \pm 3$  Ma, respectively (O'Brien *et al.*, 1994).

North of the Burin Peninsula, the volcano-sedimentary sequence can be traced northeast to the area of Bonavista Bay (Figure 1), where it is truncated by the Dover Fault (O'Brien, 1987; O'Brien and Knight, 1988). In the area of Bonavista Bay, the *ca.* 620 Ma Love Cove Group and the conformably overlying siliciclastic sedimentary rocks of the Connecting Point Group form a 5 km thick succession, referred to as the Eastport basin (O'Brien and Knight, 1988; Knight and O'Brien, 1988). A tuff bed from the middle of the Connecting Point Group stratigraphy has been dated at *ca.* 610 Ma (Dec *et al.*, 1992).

The volcano-sedimentary rocks spanning the area between the Burin Peninsula and Bonavista Bay are divisible into two broad northeast–southwest trending belts, separated by sedimentary rocks of the Musgravetown Group. These two belts represent two different packages of volcanic rocks; the Love Cove Group is confined to the eastern belt while younger volcanic rocks inferred to be related to the *ca.* 570 Ma Musgravetown Group dominate the western belt (O'Brien *et al.*, 1992; O'Brien and Holdsworth, 1992). Both the eastern and western belts contain local evidence for epithermal mineralization (*i.e.* Big Easy, Calvin's Landing; Sparkes, 2012; Figure 1). In the area of Bonavista Bay, an angular unconformity locally separates rocks of the Connecting Point Group from the overlying Musgravetown Group (O'Brien, 1993).

Several high-level plutons dominated by granitoid rocks intrude along the western margin of the Avalon Zone in Newfoundland. Most occur within the Burin Peninsula area and form a broad, semi-continuous, north-northeast trending plutonic belt consisting of hornblende-biotite granite, diorite and gabbro (Figure 1). Limited geochronological data are available for these plutonic units, but the Swift Current Granite (Figure 1) is locally dated at  $577 \pm 3$  Ma (O'Brien *et al.*, 1998). Other plutonic units, including the Cape Roger Mountain Granite and the "Burin Knee Granite" are inferred to be coeval with the Swift Current Granite (O'Brien and Taylor, 1983; O'Brien *et al.*, 1984). At the northeastern end of the belt, in the vicinity of Bonavista Bay, the Louil Hills Intrusive Suite is dated at  $572 +3/-2$  Ma and is interpreted to be coeval with alkaline volcanism associated with the Musgravetown Group within the western belt of volcanic rocks (O'Brien, 1987; O'Brien *et al.*, 1989). In the area northwest of the Burin Peninsula, the Long Harbour Group is locally intruded by the Cross Hills Intrusive Suite, which has a preliminary age of  $547 +3/-6$  Ma and hosts Zr–Nb–REE mineralization (Tuach, 1991). Devonian magmatism following the accretion of the Avalon Zone during the Acadian orogeny resulted in the emplacement of large granitic plutons across the boundary between the Avalon Zone and the adjacent Gander Zone to the west. These intrusions are accompanied by variably developed granophile (Mo, W, F, base metals) mineralization and have been the focus of intermittent mineral exploration (Kerr *et al.*, 1993a and 1993b; Kellett *et al.*, 2014).

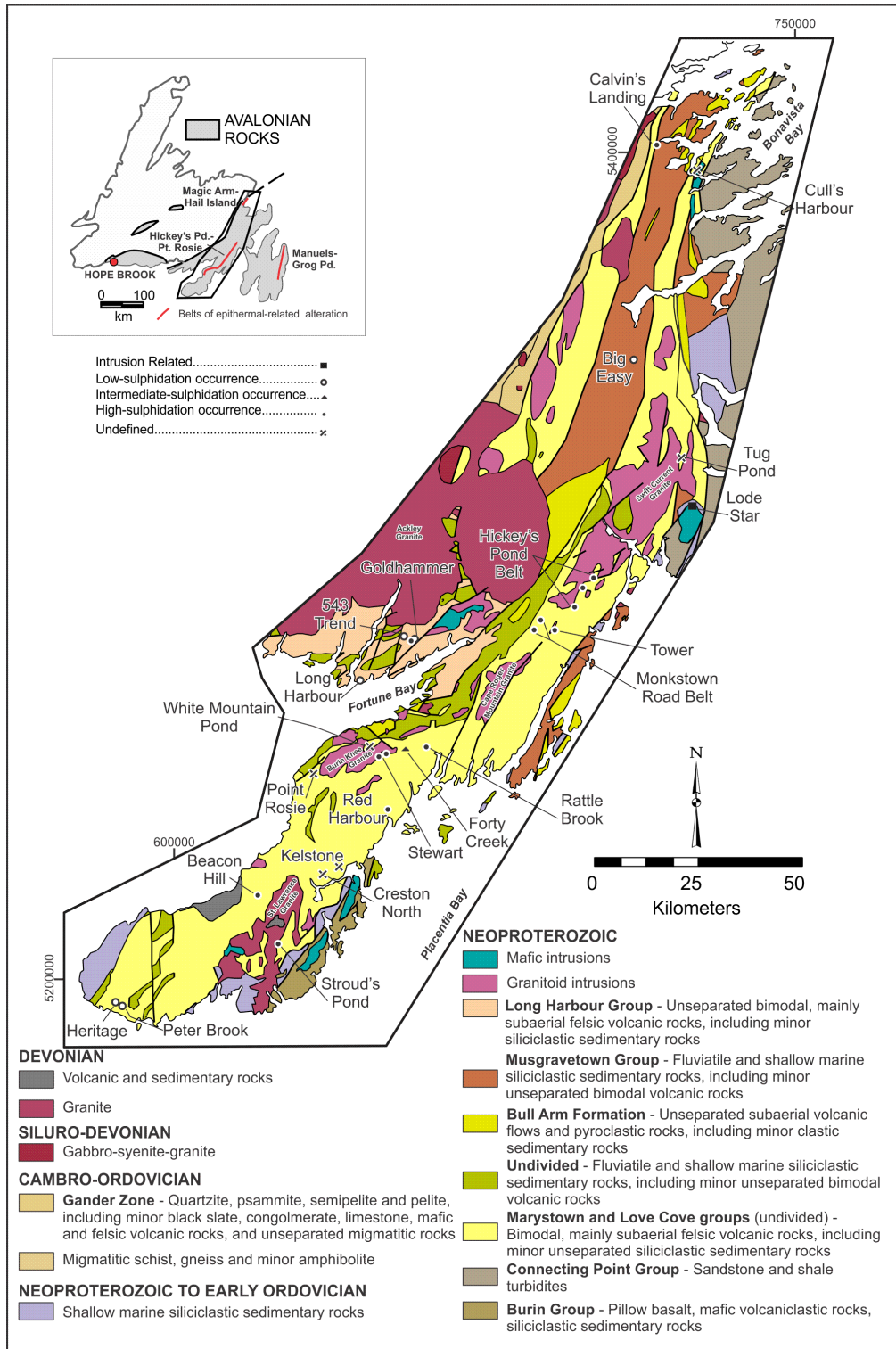


Figure 1: Regional geology map of the western Avalon Zone outlining the distribution of known epithermal prospects (modified from O'Brien et al., 1998).

## **Fluorite Mineralization on the Burin Peninsula**

### ***Introduction***

Fluorite in the St. Lawrence area was discovered in the 1800s by local residents, with the first mining possibly having been undertaken by French settlers before 1870 (Edwards, 1991). Exploration work in the early 1900s identified over 35 fluorite veins (Sparkes and Reeves, 2015). The St. Lawrence Corporation of Newfoundland started mining from the Black Duck Vein in 1933, and since then mining had continued intermittently until the early 1990s.

Fluorite mineralization has long been known to be associated with the St. Lawrence Granite (SLG), occurring as veins that are typically hosted in the granite. A few peripheral veins had been previously identified, but no significant mineralization was associated with these until the discovery of the sediment- and rhyolite-hosted AGS deposit by Canada Fluorspar Inc. (CFI) in 2013.

Fluorite in the AGS area was first discovered by Newfoundland Fluorspar Ltd. (Newfluor) at the Open Cut Pit (west end of AGS vein system) in the late 1940s, and the occurrence was called the Grebes Nest (Smith, 1957; Sparkes and Reeves, 2015). Limited diamond drilling and trenching in 1940s by Newfluor only intersected a few narrow fluorite veins east of Grebes Nest, and trenching completed by Alcan in the 1960s produced mixed results (Smith, 1957; Sparkes and Reeves, 2015). Around 1990, Minworth mined out approximately 4000 tonnes of ore from the Open Cut Pit area, and in 1999 Burin Minerals removed some material from the Open Cut Pit for lapidary and ornamental use.

Since 2012, CFI has carried out extensive exploration in the St. Lawrence area, including in the AGS area (Sparkes and Reeves, 2015). The program included ground Horizontal Loop Electromagnetic (HLEM) Max-Min and magnetometer surveys, airborne VTEM and magnetometer surveys, prospecting, mapping, trenching and drilling. In 2013, based on the results of the geophysical surveys, drilling and trenching were undertaken in the AGS area, which resulted in the discovery of the AGS deposit.

### ***Fluorite uses and market***

The mineral fluorite ( $\text{CaF}_2$ ) is the main source of fluorine that has a wide variety of industrial uses. Fluorite ore is divided into three main types based on the purity. 'Acid grade' fluorite (more than 97% fluorite) is used in oil refinery, production of organofluorine compounds (Teflon, refrigerants, Freon, etc.), and in etchant and cleaning agents

(<https://www.earthmagazine.org/>, USGS webpage: <https://minerals.usgs.gov/minerals/>). 'Ceramic grade' fluorite (85–97% fluorite) is used in manufacturing of opalescent glass, enamels and cooking utensils. 'Metallurgical grade' fluorite (60–85% fluorite) is used as a flux in steel and aluminium production.

World production of fluorite gradually increased through most of the 20th century, but declined slightly in the early 1990s due to restrictions in chlorofluorocarbon (CFC) use in refrigerants (USGS: <https://minerals.usgs.gov/minerals/>). The leading producers of fluorite, in decreasing order, are China, Mexico, Mongolia, South Africa, Vietnam and Kazakhstan.

### ***St. Lawrence Granite***

The SLG is a north-trending intrusion outcropping over an approximate area of 30 by 6 km (Teng, 1974; Figure 2). Four phases of the granite have been described by Teng (1974) that include coarse-grained granite, medium-grained granite, fine-grained granite and porphyritic granite. The contacts between the different phases are sharp. Tuffisites, consisting of fragments of granite in a fine-grained material of similar composition, are common. Quartz–feldspar porphyritic (rhyolite) sills occur to the west of the SLG, specifically in the AGS area, as noted by both Van Alstine (1948) and Teng (1974). The sills generally dip gently to moderately to the north.

The granite is composed of quartz, orthoclase and albite and minor amounts of riebeckite, aegirine, biotite, fluorite, magnetite and hematite (Teng, 1974). Chlorite occurs as an alteration from biotite. The rhyolite porphyry consists of the same minerals and has a porphyritic texture, where the phenocrysts are composed mainly of euhedral quartz and potassic feldspar.

The SLG intruded along pre-existing normal faults that influenced the northerly elongated shape of the granite in a direction of 10° (Teng, 1974). Tension fractures perpendicular to the normal fault (~100°), and associated shear structures (~60° and 140°) controlled the orientation of the fluorite veins (see below).

The SLG is interpreted to have been intruded at shallow depth based on the presence of extensive dyke swarms of rhyolite porphyries, preserved portions of a volcanic cover sequence (Rocky Ridge Formation), miarolitic cavities, gas breccias (tuffisites), and vuggy pegmatitic segregations indicative of volatile exsolution (Van Alstine, 1948; Strong et al., 1978a; Kerr et al., 1993a, b). The shallow depth is also indicated by the complex textures observed due to various degrees of undercooling typical at shallow levels: granophyric, micrographic, perthitic textures, quartz and feldspar phenocrysts surrounded by dendritic, fine-grained feldspar (Candela, 1997). The same minerals forming groundmass and phenocrysts in rhyolite suggests two-stage cooling.

The SLG is a highly fractionated, ferroan, A-type (within-plate), peralkaline granite with an average of 1083.74 ppm F content (Teng, 1974; Kerr et al., 1993a; Magyarosi, 2018). It is enriched in REE's and some trace elements (Rb, Th, U) compared to chondrites and has negative Eu, Sr, Ba and Ti anomalies.

A Rb–Sr age for the SLG of  $334 \pm 5$  Ma (Bell et al., 1977) was recalculated by Kerr et al. (1993b), to 315 Ma. However, the most recent and likely the more accurate dating of the intrusion yielded an age of  $374 \pm 2$  Ma with U–Pb in zircon (Kerr et al., 1993b). The rhyolite sill in the AGS area was recently dated with U–Pb in zircon and yielded  $377.2 \pm 1.3$  Ma, suggesting a slightly older, but overlapping age with the SLG (Dunning, 2018, unpublished).

The SLG is one of many Devonian postorogenic granites that intruded the Avalon and Gander zones (Kerr et al., 1993a). The source of the SLG was probably a mixture of mantle derived magmas and late Precambrian crustal rocks (Kerr et al., 1993a). Trace element plots suggest both K-feldspar and plagioclase fractionation occurred. The high fluorine is postulated to have originated from fluorine being trapped in hornblende in the source of the SLG (Van Alstine, 1976).

### ***St. Lawrence fluorite deposits***

The fluorite deposits in St. Lawrence have been the focus of many studies including Van Alstine (1948, 1976), Williamson (1956), Teng (1974), Teng and Strong (1976), Strong et al. (1978a), Richardson and Holland (1979), Strong (1982), Strong et al. (1984), Collins (1984), Irving and Strong (1985), Gagnon et al. (2003), Kawasaki and Symons (2008), Kawasaki (2011), Sparkes and Reeves (2015) and Reeves et al. (2016). The following is a summary from these studies.

Fluorite mineralization associated with the SLG formed as open-space fillings in tension fractures that were created by regional stresses and contraction resulting from the cooling of the granite. Fluorine-rich volatiles separated from the cooling granite, and escaped along structures to be subsequently deposited in fractures in the upper part of the granite. Repeated movement along fractures resulted in the brecciation of host rocks and pre-existing vein material, thus creating space for several successive phases of fluorite mineralization. Volatiles generally did not escape into the host sedimentary rocks due to the impermeability of the hornfelsed sediments overlying the granite (Teng, 1974; Strong, 1982). As such, most of the fluorite veins are hosted in the granite. Further, the lack of fluorite veins in the country rocks may be due to open fissures, formed as a result of cooling in the granite, narrowing and closing as they passed from the granite into the country rocks that were not subjected to cooling and contraction (Williamson,

1956). The AGS vein system is an exception, being hosted in sedimentary rocks and rhyolite sills intruding the sediments (see below). The fluorite veins are epithermal, suggested by low temperature and pressure assemblages, vuggy veins, abundance of breccia, and colloform and crustiform structures.

The main control on fluorite deposition is an increasing pH caused by the boiling of magmatic fluids (Strong et al., 1984). Fluid-inclusion studies suggest that the fluorite formed between temperature ranges of 90 and 500°C, with both increasing and decreasing temperatures observed during crystal growth. Formation pressures were between 65 and 650 bars. Oxygen isotopes suggest mixing of magmatic fluids with cool meteoric fluid. Also, REE concentrations in the different ore zones and textural types of fluorite indicate a magmatic origin (Strong et al., 1984).

There are more than 40 fluorite veins in the St. Lawrence area, ranging in size from a few cm to 30 m in width and up to 3 km in length (Figure 2). There are variations in thickness along strike and with depth. Four major types of fluorite veins have been described:

1. North–south-trending low-grade veins (Tarefare, Director, Hares Ears, Blue Beach North and South);
2. East–west-trending high-grade veins (Black Duck, Lord and Lady Gulch, Iron Springs, Canal);
3. Northwest–southeast-trending veins in sedimentary rocks containing high-grade mineralization (AGS); and
4. East–west-trending peripheral veins containing significant amounts of barite with fluorite (Meadow Woods, Lunch Pond, Clam Pond, Anchor Drogue).

In addition to the differences in the orientation and grade between the major types of fluorite veins, Van Alstine (1948), Williamson (1956), Wilson (2000) and Reeves et al. (2016) also noted the predominance of green fluorite and increased amount of sulphides in the peripheral veins and veins not hosted in granite compared to the granite-hosted veins.



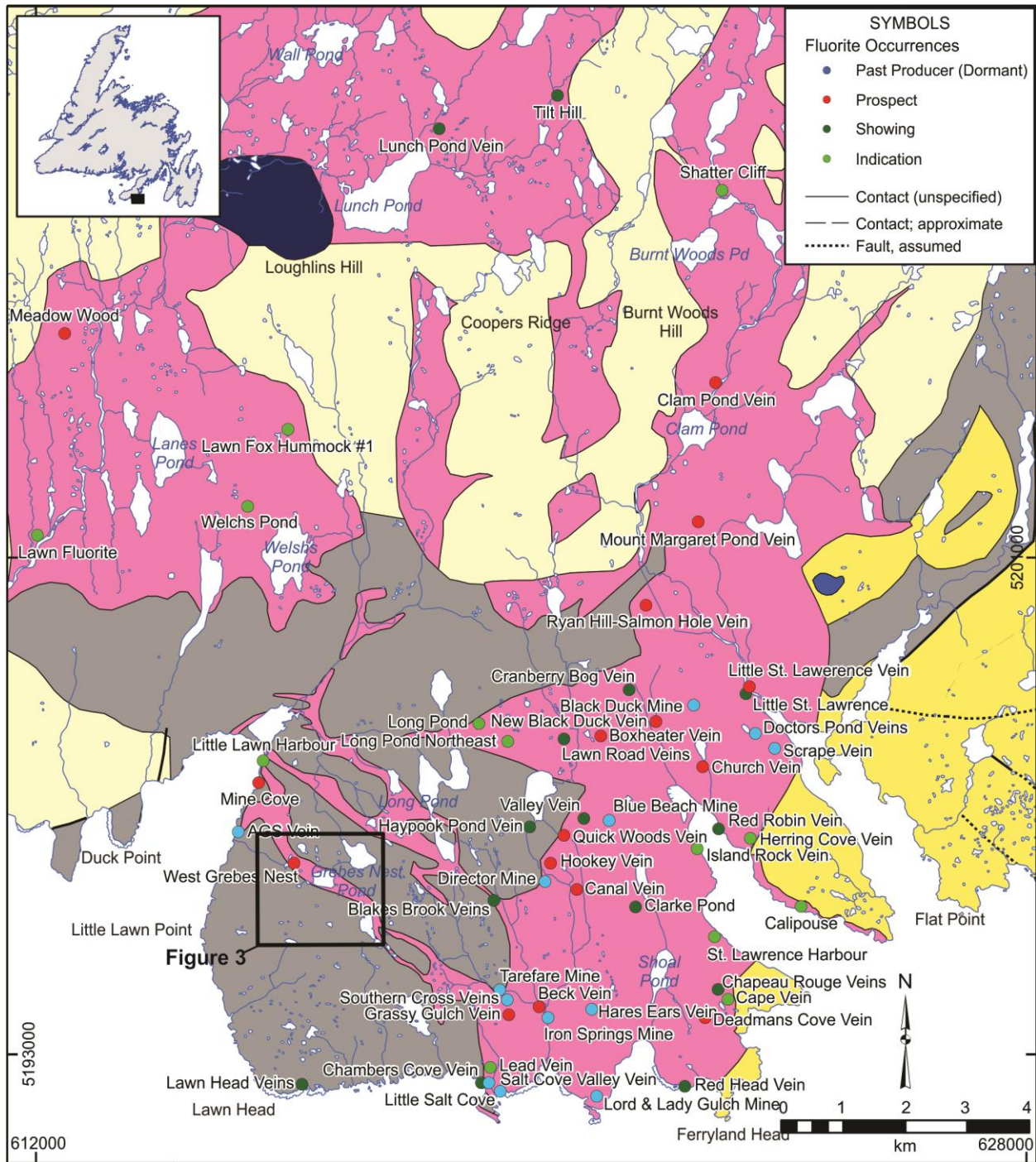


Figure 2: Fluorite occurrences in the St. Lawrence area (MODS, Geological Survey of Newfoundland and Labrador)

## **Trip Itinerary**

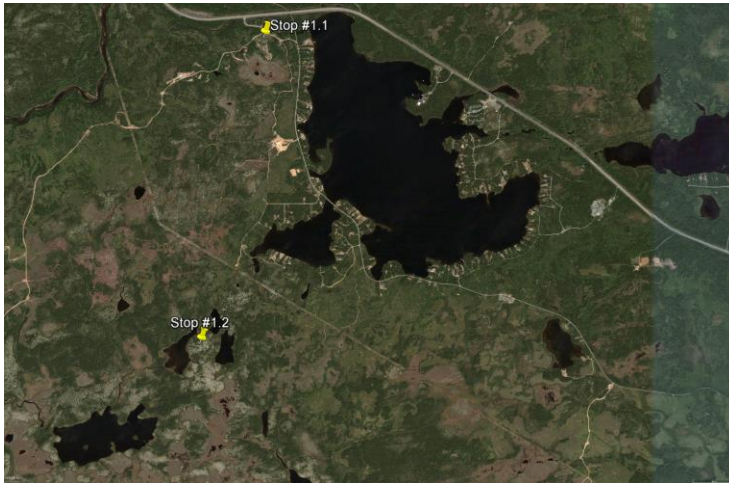
During the afternoon of day one we will begin by examining a well-preserved, Neoproterozoic, low-sulphidation, epithermal environment hosted within sedimentary rocks of the Musgravetown Group along the western Avalon Zone, near the town of Clarendville. Following this, we will travel to the Burin Peninsula region where we will view some of the older arc-related volcanic rocks of the Marystown Group as well as the Devonian Ackley Granite.

During day two, we will travel to St. Lawrence to view the active open pit fluorspar mine and then move on to view some of the surrounding geological contacts of the St. Lawrence Granite as well as some of the historical mine workings in the area. Day three of the field trip will examine some skarn-related mineralization developed marginal to the St. Lawrence Granite and then move onto some examples of epithermal mineralization within the Marystown Group, in addition to making stops to look at regionally extensive geological units and take in some of the local scenery before heading back to St. John's in the mid-afternoon.

UTM coordinates are provided for stops for the convenience of future guidebook users. Note that these are all with reference to the NAD 1927 map datum and UTM Zone 21.

# DAY ONE FIELD TRIP STOPS

## Stop 1.1: Musgravetown Group



*Plate 1: Location reference for Stop 1.1 (UTM 710338E/5351012N) and subsequent stop at the Big Easy prospect (Stop 1.2 on map).*

*From Clarendville, continue to Thorburn Lake and turn left on a gravel road just past the lake, located 7 km north (beyond) the junction for the Discovery Trail (Route 230) and the TCH. Stop at the quarry approximately 200 m along the road.*

Here the quarry primarily consists of grey-green coarse-grained sandstone of the Musgravetown Group, locally displaying well-developed cross-bedding. These rocks dip moderately to the west and are inferred to have a faulted contact with the Love Cove Group volcanic rocks to the east. This stop illustrates the style of sedimentation and the relatively undeformed nature of the Musgravetown Group outside of the alteration zone that will be observed at the following stops. Immediately north of this location, on the northern side of the highway, are flow-banded rhyolites which immediately underlie these sedimentary rocks; these rhyolites have been dated at  $573.3 \pm 2.7$  Ma (Ferguson, 2017).

### ***Drill Core Display***

We will also take this opportunity to view some select examples of the well preserved low-sulphidation related features intersected in drillcore that has been borrowed from the government core storage library in St. John's. In particular, we will examine syn-sedimentary silica gels formed within a "sinter"-like environment and the locally auriferous crustiform-colloform chalcedonic silica veining that is characteristic of the prospect.

## Stop 1.2: Gold Mineralization at the Big Easy Prospect

*From Stop 1.1, continue on the gravel road. There is an area suitable for parking at UTM 710335E/5349106N, which is relatively close to the powerline. From here an ATV trail leads to the main occurrence (Plate 1) and side trails lead to the other locations discussed below. Waterproof footwear is highly recommended for this section of the field trip.*

The area near Thorburn Lake was examined by GT Exploration Limited in the mid-1990s (Harris, 1996). Initial interest in the area was generated by an anomalous lake sediment sample containing 10 ppb Au. Subsequent prospecting led to the discovery of a silica–pyrite alteration zone, which locally assayed up to 196 ppb Au, and measured up to 500 m in width and 1.8 km in length (Harris, 1996); however no further work was carried out on the prospect. In 2010, Silver Spruce Resources resumed exploration and carried out trenching and diamond drilling, which led to the discovery of well-developed low-sulphidation-style chalcedonic silica veins and related brecciation (*i.e.* Big Easy prospect; Silver Spruce Press Release, July 29, 2010). Trenching has also uncovered large blocks of layered chalcedonic silica material interpreted as sinter deposits related to hot springs (Silver Spruce Resources Press Release, November 3, 2010). Subsequent drilling has now produced some of the highest grade gold intersections within low-sulphidation-style epithermal systems in the Avalon Zone of Newfoundland. The first phase of diamond drilling on the property, in which the holes were oriented to the east returned up to 0.87 g/t Au and 33.5 g/t Ag over 30.5 m, including 6.05 g/t Au and 174 g/t Ag over 1.5 m (DDH BE-11-03) as well as local intersections of up to 7.65 g/t Au and 10 g/t Ag over 1 m (DDH BE-11-07; Silver Spruce Resources Press Release, May 3, 2011). The second phase of drilling was directed towards the west and intersected better vein development which locally returned values of up to 7.9 g/t Au and 130 g/t Ag over 1.2 m (Silver Spruce Resources Press Release, August 16, 2012).

The host volcanoclastic sedimentary rocks at the Big Easy prospect are correlated with the late Neoproterozoic Musgravetown Group (Meyer *et al.*, 1984). The area immediately north of the Big Easy prospect, in the vicinity of Clode Sound, was mapped by O'Brien (1993). In this area, the Musgravetown Group is described as consisting of coarse-grained, mainly red, fluvialite clastic sedimentary rocks with locally developed basal conglomerate, overlain by a bimodal volcanic sequence. A rhyolite unit from the base of the Musgravetown Group has been dated at *ca.* 570 Ma and the sequence is locally unconformably overlain by Cambrian sedimentary rocks (Hayes, 1948; O'Brien, 1987; O'Brien *et al.*, 1989). Within the immediate area of the Big Easy prospect, the sedimentary rocks distal to the development of the silica–pyrite alteration consist of red, coarse-grained sandstone and lesser interbedded pebble to cobble conglomerate. The extensive silica–pyrite alteration at the prospect hinders recognition of the host rocks, but relict rounded sedimentary clasts are locally observed suggesting that the host rock is similar to the

surrounding sedimentary rocks outside the main alteration zone. A mafic dyke collected from drillhole BE-11-03, which crosscuts the silica alteration, was dated at  $566 \pm 2$  Ma (Clarke, 2012), demonstrating the Neoproterozoic age of the low-sulphidation system. The preservation of surficial sinter deposits in a low-sulphidation system of this age makes this occurrence very unique.

Veins measuring up to 50 cm in width, displaying typical low-sulphidation-style textures such as crustiform–colloform banded chalcedonic silica and relict lattice blading. Some of the veins crosscut sedimentary layering at a relatively high angle. In addition, large blocks (interpreted to represent subcrop) containing cm-scale layers of chalcedonic silica interlayered with coarse-grained sandstone are also present. Elsewhere, fragments of similar chalcedonic material form clasts within coarse conglomeratic units. These relationships suggest the formation and simultaneous erosion of epithermal sinter deposits during the deposition of the late Neoproterozoic Musgravetown Group.

#### ***Stop 1.2a: Unaltered Musgravetown Group***

We will first visit the area of drillhole BE-11-06. In the vicinity of the drillhole collar, large blocks (interpreted as subcrop) illustrate the red coloration of the unaltered sandstone and interbedded pebble conglomerate. A small stream separates the unaltered and altered rock in this area; however the contact in drillcore is preserved as a sharp faulted contact.

#### ***Stop 1.2b: Trench 7***

We are now into the main alteration zone, which consists of silicification and white mica alteration of the host sedimentary rocks. At this location several 10-20 cm wide chalcedonic silica veins cut across the outcrop. Note the difficulty in seeing the veins on the lichen-covered portion of the outcrop versus the stripped portion of the outcrop.

#### ***Stop 1.2c: Trench 4***

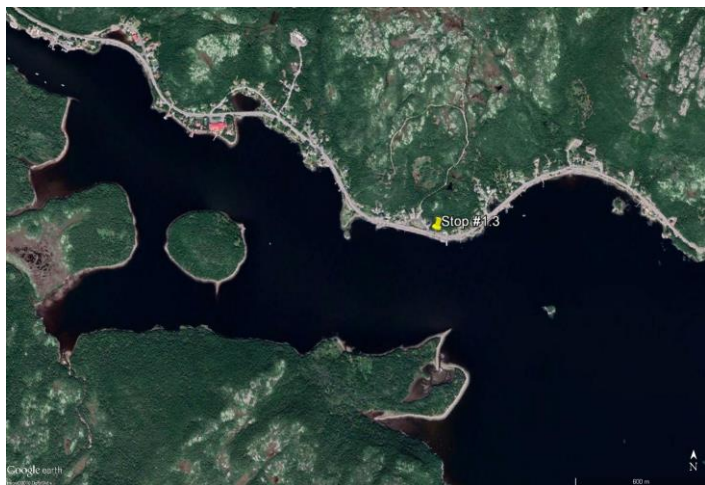
Here we continue to move along strike within the alteration zone. Locally, relict bedding within the host sedimentary sequence appears to be westward dipping, and this is interpreted to still be the same host rock as observed at the last stop.

#### ***Stop 1.2d: Trench 6***

This trench represents the southernmost exposure of the alteration zone. Here, layers of chalcedonic silica can be seen interbedded with the volcanoclastic sandstone. Locally, chalcedonic silica veins crosscut the sinter at relatively high angles to bedding. These large blocks of sinter material are interpreted as subcrop, as the bedding orientations do not seem to

match with those taken elsewhere in the immediate vicinity. Drillhole BE-11-01, which was located just to the west of this location, and oriented towards the east, failed to intersect any significant sinter material in drillcore.

### Stop 1.3: Swift Current Granite



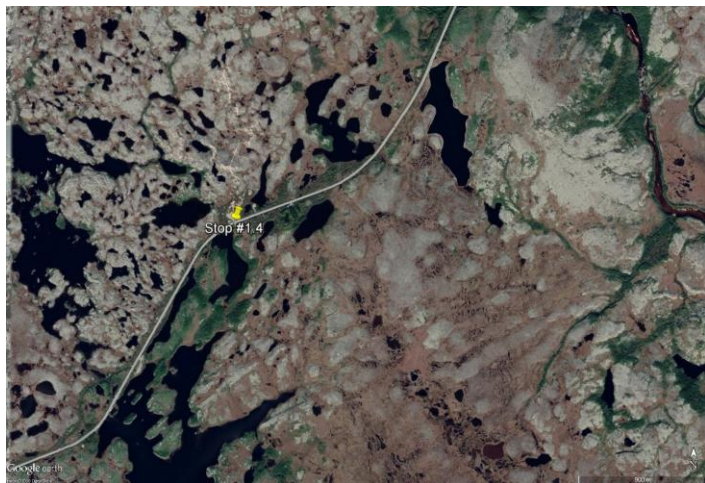
*Plate 2: Location reference for Stop 1.3, located within the town of Swift Current (UTM 709216E/5306437N).*

*From Thorburn Lake, turn east on the TCH and proceed to the Goobies turn-off, then proceed along route 210 to the town of Swift Current. Stop 1.3 is located just east of the eastern entrance to Old Church Road. This is a roadside outcrop so please be aware of oncoming traffic!*

This roadcut within the town of Swift Current exposes meter scale pendants of Marystown Group volcanic rocks within the roof of the Swift Current pluton. The Swift Current pluton is part of a regionally extensive suite of *ca.* 575 Ma granitic plutons that are associated with a number of occurrences of porphyry-style and epithermal vein deposits within the Burin Peninsula (Ferguson et al, 2014).

At this site, localized interaction of the wallrock volcanic rocks with the water-saturated cap of the Swift Current pluton has produced 10-30 cm selvages of actinolite-epidote within the immediate wall of the granite.

## Stop 1.4: Ackley Granite

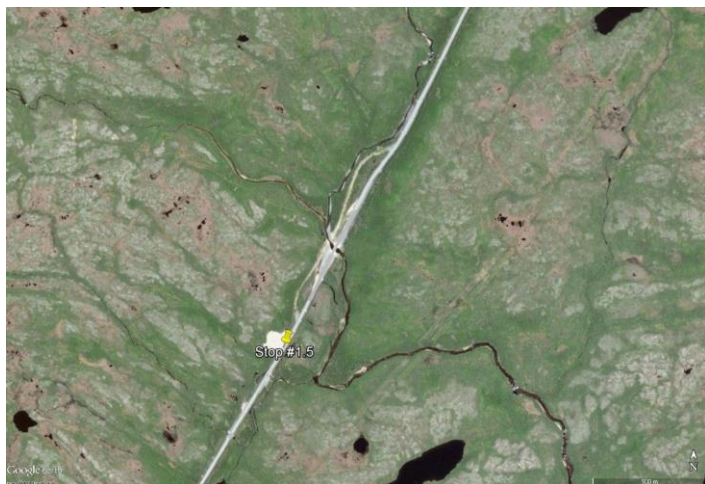


*Plate 3: Location reference for Stop 1.4, located along route 210; Sandy Harbour River Interpretive Viewpark (UTM 688331E/5296831N).*

*From the town of Swift Current, proceed south along route 210 for approximately 30km until reaching the Sandy Harbour River Interpretive Viewpark, located on the right hand side of the road.*

We are now within the regionally extensive Ackley Granite, which represents a Devonian post-orogenic intrusion that intrudes along the Gander-Avalon tectonic boundary (Williams, 1979; Dickson, 1983; Tuach *et al.*, 1986; Tuach, 1987; Kellett *et al.*, 2014). The majority of the boulders located throughout the park consist of the Ackley Granite, and outcrops of similar material occur along route 210 approximately 850m to the southwest. Approximately 3.8km to the southwest, a large outcrop exposure just off the main highway contains several large cut blocks that have been extracted from the granite during a past evaluation of its suitability as a dimension stone; however, there has been no commercial production of stone from the site.

## Stop 1.5: Felsic Volcanic Rocks of the Marystown Group/ Rattle Brook Prospect



*Plate 4: Location reference for Stop 1.5, located along route 210; Rattle Brook (UTM 661651E/5256733N).*

*From Stop 1.4, proceed south along route 210 for approximately 50km until reaching Rattle Brook. A well exposed quarry face occurs on the west side of the road about 500m past the brook. This is a roadside outcrop so please be aware of oncoming traffic!*

A small quarry on the west side of the main highway exposes felsic volcanic rocks of the Marystown Group. The predominant lithology in the quarry is a well-preserved felsic crystal tuff that includes welded fiamme, as well as “dark flattened fragments” that may have been incorporated from underlying host rocks during eruption.

Immediately north of this area is the Rattle Brook prospect, which represents an occurrence of advanced argillic alteration hosted within the volcanic rocks of the Marystown Group. Here the alteration is developed close to a fault structure which separates mafic volcanic rocks to the north, from felsic volcanic rocks to the south. Local intense silicification in association with pyrophyllite-alunite-dickite alteration is associated with anomalous gold mineralization. The hydrothermal alteration can be traced along strike for approximately 1.5km, where it pinches out along a fault towards the west-northwest.

This area is unusual with respect to the regional northeast trending Hickey’s Pond – Point Rosie Alteration Belt because here the overall trend of the alteration and the associated fabric within the host rock become deflected toward a more east-west orientation. Further along this trend towards the west-southwest are the Forty Creek and Stewart prospects (Sparkes, 2012; Ferguson, 2017). The Forty Creek prospect represents an example of intermediate-sulphidation-style mineralization, locally hosting up to 59 g/t Au and 2290 g/t Ag in association with lead and silver telluride minerals. The nearby Stewart prospect represents a zone of advanced argillic alteration extending for upwards of 4 km in length and up to 700 m in width, locally hosting anomalous Au and Cu mineralization. This zone may represent a telescoped epithermal system with the advanced argillic alteration superimposed on the underlying porphyry-related mineralization.



## Stop 1.6: Mortier Bay Look Out



*Plate 5: Location reference for Stop 1.6, located along route 210; Mortier Bay Look Out (UTM 643220E/5228860N).*

*From Stop 1.5, proceed south along route 210 for approximately 35km until reaching the Mortier Bay Look Out.*

This stop provides a scenic view overlooking Mortier Bay. Across the bay to the east, Carboniferous conglomerates are known to host rare cobbles of auriferous silica alteration associated with white mica and locally pyrophyllite alteration in the area of the Spanish Rooms prospect. These clasts are interpreted to be sourced from the underlying mineralized volcanic rocks of the Marystown Group, which locally underlie the unconformity with the Carboniferous rocks. To the west, the regional northeastern trend of geological units is interrupted by an east-west trending belt, consisting of basalt and lesser intermediate and felsic pyroclastic rocks, known as the Mortier Bay Group (Strong *et al.*, 1978a). The relationship between these rocks and those of the Marystown Group remains unclear, and although the Mortier Bay Group appears to truncate the regional trend of the Marystown Group, the two units are inferred to be of broadly similar age (Strong *et al.*, 1978a).

Rocks included within the Mortier Bay Group host the Creston North prospect, which contains zones of silica-pyrite alteration and hydrothermal brecciation in association with white mica alteration. These features are locally accompanied by Au-Ag mineralization and resemble low-sulphidation-style mineralization developed elsewhere in the region.

## DAY TWO FIELD TRIP STOPS

The field trip stops for Day 2 are located in the St. Lawrence area and focus on the fluorite mineralization in the newly discovered, sediment-hosted AGS deposit and some of the granite-hosted veins.

### Stop 2.1: AGS Open Pit



*Plate 6: Location reference for Stop 2.1 (UTM 616843E/ 5195700N).*

*The AGS open pit is operated by CFI and can be accessed only with their permission. To access the mine site, take Route 220 west from St. Lawrence towards Lawn and turn left approximately 1.5 km from St. Lawrence onto CFI's access road. Follow the road until the gate to the mine.*

***This is an operating mine. There will be a brief orientation about safety and personal protective equipment (hard hat, safety glasses, gloves and steel-toed boots) must be worn at all times.***

The AGS vein system, as currently defined, is approximately 1.85 km long and consists of several fluorite veins running almost parallel to each other, with local pinching and swelling observed (Sparkes and Reeves, 2015; Reeves et al., 2016; Figures 3 and 4). The majority of the veins strike southeast ( $\sim 110^\circ$  to  $130^\circ$ ) and dip steeply ( $\sim 80^\circ$  to  $85^\circ$ ) to the southwest. There are also several smaller east-west striking and steeply dipping veins in the AGS area (Sparkes, B. Written Comm., 2018). The veins are fault-controlled and range in width from less than 2 m to up to 30 m. The strike length of major veins is between 400 and 700 m. The three major veins include the North, South and GNP veins.

The veins are hosted in sedimentary rocks, as well as in rhyolite sills that intrude the sediments and dip gently to the north. The sedimentary rocks are dark-grey to green shales of the Inlet Group. The rhyolite has a porphyritic texture and is composed of quartz and feldspar (orthoclase and minor amounts of plagioclase) phenocrysts in a groundmass composed of the

same minerals and minor amounts of chlorite alteration. Trace amounts of zircon, rutile and several REE minerals (monazite, xenotime, thorite) also occur in the rhyolite. The rhyolite is an early phase of the SLG, suggested by their similar geochemistry and recent age dating (see above). The rhyolite likely separated from the SLG when it was still partially melted and intruded at shallower levels, where it cooled faster. No field relationships between the rhyolite sills and the SLG in the AGS area have been observed to date (Sparkes B, Written Comm., 2018). The SLG underlies the AGS area and has been intersected by deeper drillholes between 250 and 350 m (Sparkes and Reeves, 2015).

The amount of fluorite in the AGS vein system has been calculated by CFI based on drilling (Sparkes and Reeves, 2015). In 2014, the resource was 9 389 049 tonnes at 32.88% fluorite (NI 43-101 compliant).

Fluorite is the main mineral in the veins and occurs in purple, yellow, green, blue, grey, white, red, pink and tan. The pink and tan occur in fine-grained, banded fluorite ore and the colour is likely due to the presence of fine-grained hematite. Purple fluorite varies from being fine or coarse grained, whereas the other coloured fluorites are typically coarse to very coarse grained.

Quartz is a very common accessory mineral, especially in the earlier phases of hydrothermal activity (barren breccia, purple fluorite) and in the late phases (blastonite, late quartz). Calcite is especially common in the High Carbonate Zone, in parts of the Grebes Nest Pit (Sparkes and Reeves, 2015), where the amount of calcite in the veins may locally reach 50% or more. Barite was observed, using the Scanning Electron Microscope (SEM), as small grains in some samples. Sulphide minerals identified include sphalerite, galena, pyrite and chalcopyrite. Sulphides are more common in samples from the Open Cut Pit. Hematite is locally common and typically occurs intergrown with chalcedony or quartz and fluorite. Other unusual minerals include willemite ( $Zn_2SiO_4$ ) and cerussite ( $PbCO_3$ ).

Table 1 shows the paragenetic sequence observed in the AGS area (Sparkes and Reeves, 2015; Reeves et al., 2016; Magyarosi, 2018).

The two main controls on fluorite mineralization in the AGS area are the rhyolite sills and the high-angle, strike-slip faults (Figures 3 and 4). Movement along the strike-slip faults was mostly sinistral. The sills are cut by the faults, but the fault was probably active prior to the intrusion of the rhyolite sills. The fluorite veins follow the faults and repeated movement along them allowed for deposition of several phases of fluorite mineralization. Fluid inclusion data suggests that the fluorite in the AGS area formed between 90 and 170° C and salinities between 9 and 28 wt% NaCl equivalent.

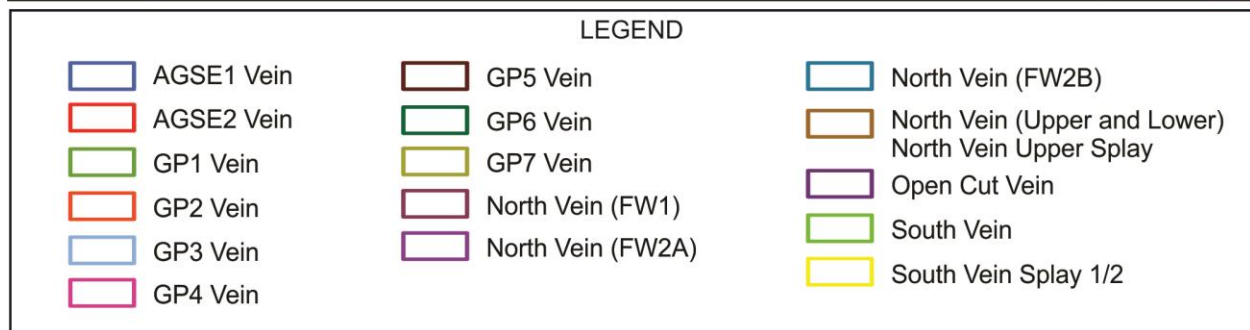
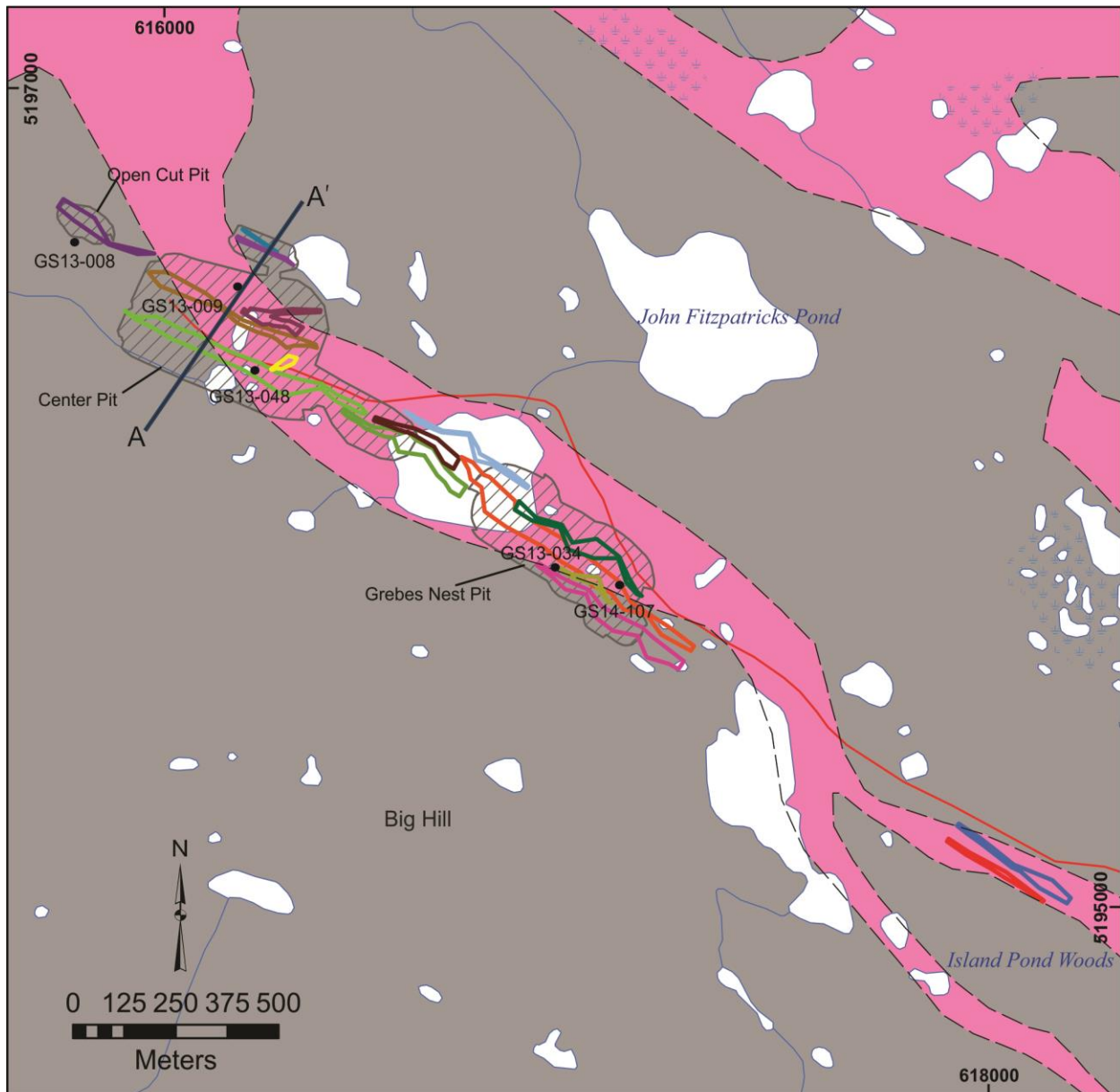


Figure 3: Plan map of the AGS area showing veins of the AGS vein system (modified after surface plan map prepared by Sparkes, CFI in 2016). Black dots are locations of drill hole collars.

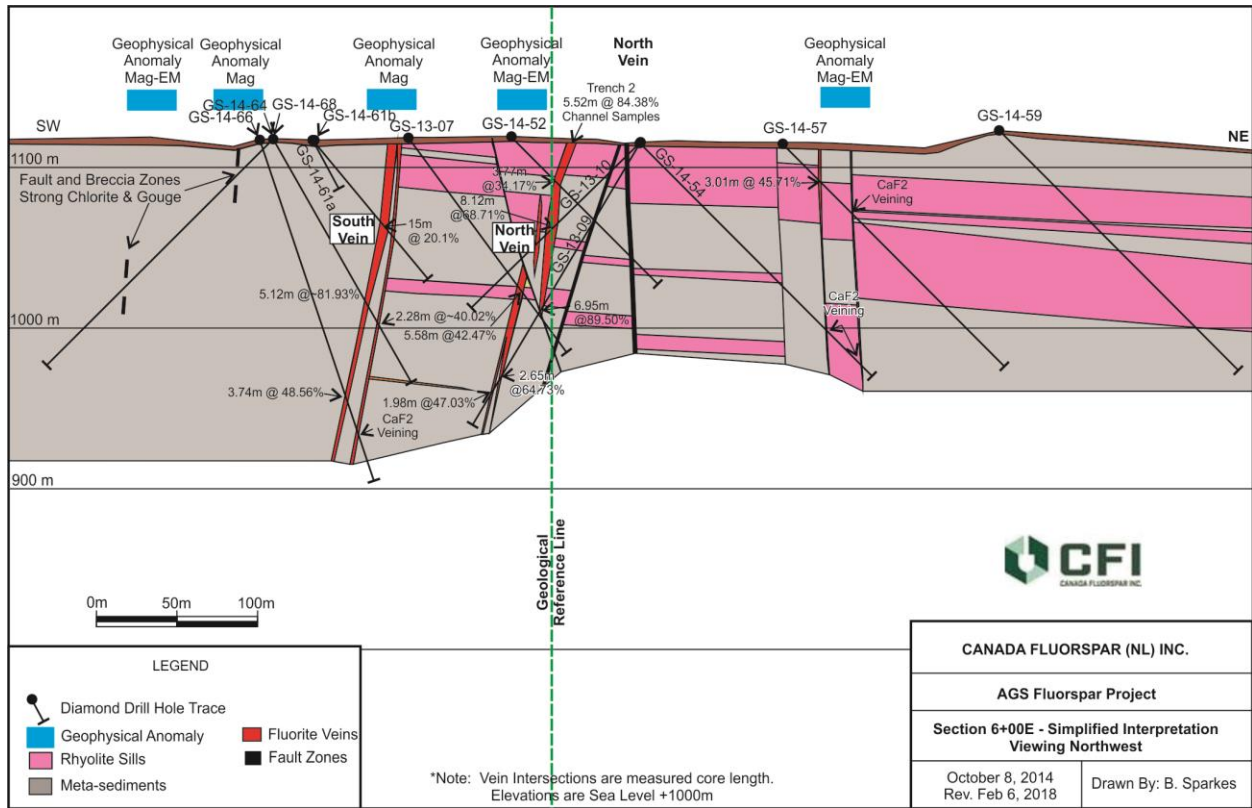


Figure 4: Cross-section of AGS vein system in the Center Pit area looking northwest (after Sparkes and Reeves, 2015)

*Table 1: Paragenetic sequence of hydrothermal events in the AGS area*

	<b>Phase</b>	<b>Description</b>
1	Brecciation of host rocks	Brecciated, weakly- to strongly-altered sedimentary rocks and rhyolite in a quartz-rich matrix
2	Purple fluorite stockwork and/or hydrothermal breccia	Purple fluorite and quartz forming stockwork veins and hydrothermal breccia with clasts of host rocks
3	Banded, fine-grained fluorite and/or coarse-grained yellow fluorite	Finely banded, fine-grained fluorite and locally calcite and/or coarse-grained yellow fluorite with black calcite, locally alternating
4	Chalcedony-fluorite	Chalcedony surrounded by quartz and fluorite, more common at Center and Open Cut Pit
5	Reddish grey fluorite	Massive, coarse-grained, grey, transparent fluorite, locally slightly reddish or pink, possibly due to trace iron
6	Grey elongated fluorite	Massive, grey fluorite with elongated crystals up to 20 cm in length. This phase is separated from the previous phase by a ~1 cm wide band of fine-grained sulphides (sphalerite and galena).
7	Green, blue and white, coarse-grained fluorite locally with abundant calcite	Alternating layers of coarse-grained fluorite and locally calcite
8	Clear or blue, cubic fluorite	Clear or blue cubic fluorite occurs filling later vugs
9	Blastonite	Breccia composed of fragments of previous phases in a matrix composed of quartz, calcite (in calcite-rich areas) and fine-grained fluorite
10	Late quartz	Quartz filling late vugs in previous phases

## Stop 2.2: Chamber's Cove: Contact of SLG with overlying sedimentary rocks and the Little Salt Cove and Chamber's Cove fluorite veins



*Plate 7: Location reference for Stop 2.2 (UTM 619393E/5192269N).*

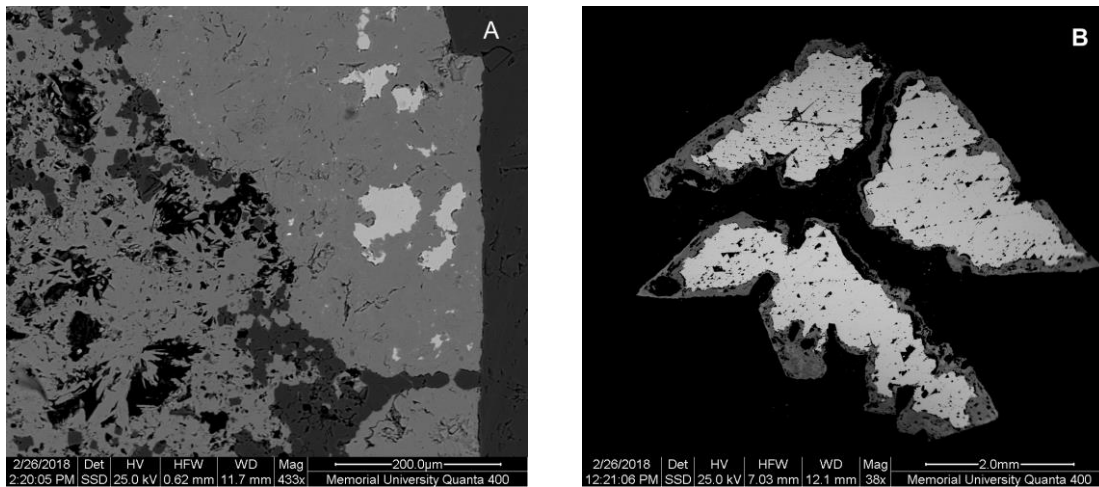
*In St. Lawrence turn left on Laurentian Avenue from Route 220, then turn right onto Pollux Crescent and follow that gravel road to Chamber's Cove, passed the old Iron Springs mine site.*

***The outcrops are cliffs along the ocean shore. Please do not climb up on the cliffs, watch for falling rocks and no hammering. Stay away from the ocean, as the waves can be unpredictable. The rocks are very slippery when wet and/or covered with seaweed.***

The contact of the SLG with the overlying sedimentary rocks is exposed along the shoreline. Sediment is hornfelsed by SLG and the fluids were trapped in SLG “autometasomatizing” the granite (Strong, 1982). The contact is sharp and the SLG has a chilled margin (fine-grained) along the contact. The composition of the granite from this location differs from the rest of the SLG with lower SiO<sub>2</sub>, higher CaO, Al<sub>2</sub>O<sub>3</sub> and BaO contents. The SLG is locally strongly altered along the contact with fluorite, barite and sulphides (pyrite, chalcopyrite, galena, sphalerite) occurring either in veins or disseminated in the granite.

The Chamber's Cove vein is located close to the contact between the granite and sediment, but pinches out and disappears as it crosses the contact into the sediment. The vein is a N-S trending vein (~340/78), estimated to be 46 m long (MODS). It outcrops in Little Salt Cove and on the other side of the hill in Chamber's Cove. The fluorite is mostly green with minor amounts of light purple and blue fluorite along the edges of the vein. Gangue minerals include quartz and trace amounts of barite, galena, sphalerite and chalcopyrite (Van Alstine, 1948). Willemite (Zn<sub>2</sub>SiO<sub>4</sub>) and cerussite (PbCO<sub>3</sub>) occur replacing sphalerite and galena, respectively. The galena is argentiferous and argentite (Ag<sub>2</sub>S) was identified in the vein by Van Alstine (1948). A sample of the vein collected in the summer of 2017 yielded 8.2 ppm silver. The vein has been explored by several companies and minor operation took place by St. Lawrence Corporation of Newfoundland Ltd. in the 1930's (Smith, 1957, MODS).

The Little Salt Cove vein is hosted in granite along the shoreline and extends inland towards Chambers Cove. The orientation of the vein is approximately 305/90 along the seashore and it is estimated to be 305 m long (MODS). The fluorite is yellow, pink, grey, green, blue and purple coloured. The gangue minerals include calcite, barite and galena (Van Alstine, 1948). The host granite is moderately to strongly altered. The vein was mined in the 1930's by St. Lawrence Corporation of Newfoundland Ltd. with approximately 122 tonnes of fluorspar removed (Smith, 1957, MODS).



*Plate 8: SEM images of sphalerite surrounded by willemite (A) and galena surrounded by cerussite (B) from the Chamber's Cove vein.*



## Stop 2.3: Lord and Lady Gulch Mine

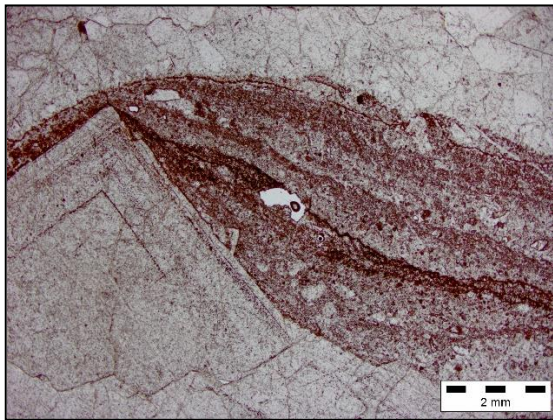


*Plate 9: Location reference for Stop 2.3 (UTM 621201E/5192393N).*

*From Chamber's Cove take the gravel road towards St. Lawrence and turn right towards Shoal Cove (sign at turn off). Keep straight on that gravel road and follow the pole line passed the turn off to Shoal Cove to the communication tower at the end of the road. There are dangerous*

*cliffs in this area, especially around the old mining operation. Please stay away from the edge and the ocean.*

The Lord and Lady Gulch Vein is also hosted in granite. It is an E-W trending vein with an approximate orientation of 080/70 and an estimated length of 366 m (MODS). The fluorite occurs as fine-grained, layered, red and beige fluorite and coarse-grained purple, blue, yellow, white and green fluorite (Van Alstine, 1948). Gangue minerals include calcite, quartz and trace amounts of pyrite, chalcopyrite, galena and barite. The vein was mined intermittently by the St. Lawrence Corporation of Newfoundland Ltd. between 1935 and 1957 and produced a total of 42,306 tons (MODS). Two phases of the granite are present along the vein: a medium-grained, equigranular, pink granite and a porphyritic granite composed of quartz and potassic feldspar phenocrysts in a light pinkish grey matrix.



*Plate 10: Coarse-grained fluorite surrounded by fine-grained, finely banded, hematitic fluorite*

## Stop 2.4: Contact of SLG and sedimentary rocks along Route 220



*Plate 11: Location reference for stop 2.4 (UTM 617551E/5200681N).*

*The contact is exposed in a road cut along Route 220, approximately 2 km west of St. Lawrence. Watch out for traffic at this stop. Please don't climb up on the cliff, watch for falling rocks and no hammering. Watch your step walking on the large boulders around the outcrop.*

The contact between the granite and overlying sediment at this location has been discussed in detail by Strong (1982) and Evans (1977). The contact is sharp and the granite has a chilled margin with quartz and feldspar phenocrysts in porphyritic texture along the contact. The granite is altered and bleached within 2 m of the contact. In altered granite the quartz and feldspar are replaced by calcite and albite. Geochemically, there is a decrease in  $\text{SiO}_2$  and  $\text{K}_2\text{O}$  and an increase in  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$  and  $\text{Na}_2\text{O}$  contents in the altered granite compared to the unaltered granite. The alteration is accompanied by the appearance of sphalerite and galena. There is an enrichment in uranium and tin at the contact.

The overlying shale is contact metamorphosed by the granite approximately 2 m from the contact (Strong, 1982). The minerals in the sediment include quartz, feldspar, muscovite, chlorite, epidote, hematite, calcite and opaque minerals. Garnet may have been present, but was replaced by chlorite, epidote and opaque minerals during retrograde metamorphism.

## DAY THREE FIELD TRIP STOPS

The field trip stops for Day 3 are all located along the southern shore of the Burin Peninsula, and will include skarn-related mineralization developed marginal to the St. Lawrence Granite, epithermal-style mineralization within the Marystown Group, and representative examples of the overlying sedimentary sequence.

### Stop 3.1: Lawn Skarn



*Plate 12: Location reference for Stop 3.1 (UTM 611068E/5200631N).*

*This stop is located in the town of Lawn. Proceed from Marystown and drive approximately 54km south along route 220. After entering the town of Lawn, turn right just before the Wilsons Gas Stop and proceed up the street to the school. The stop is located at the back of the school at the site of an old quarry.*

A small exposure of base-metal skarn mineralization is described by Prince (2009) at this location. The skarn replaces a several meter thick layer of limestone within the Cambrian Inlet Group. The skarn consists mainly of massive or banded garnet-pyroxene skarn with minor retrograde veining by amphibole-epidote-magnetite-quartz accompanied by sphalerite, chalcopyrite and trace bismuthinite.

The small quarry to the immediate north of the outcropping skarn exposes granitoid rocks affiliated with the Devonian St. Lawrence Granite, including a large composite dyke in the west wall, with a narrow fine-grained granite as the latest, central phase. One of these granitoid phases is likely the parent of the skarn mineralization, although a contact, or fault access for fluids, has not yet been recognized. The granitoid rocks show extensive “spotting” with pink epidote, which may be indicative of “endoskarn” metasomatism associated with the skarn-forming system.

### Stop 3.2: Eagle's Claw Prospect



*Plate 13: Location reference for Stop 3.2 (UTM 605766E/5197201N).*

*From Stop 3.1, proceed back to route 220 and turn right; continue southwest for approximately 16km until reaching an old abandoned quarry on the right hand side of the road.*

This small abandoned quarry provides an opportunity to examine volcanic lithologies of the Marystown Group mapped by O'Brien et al (1977) as part of the Taylors Bay Sequence. A new gold showing, the Eagles Claw prospect, is located within the quarry and has produced grab samples of up to 4g/t Au and 40 oz/t Ag from quartz veining developed within the quarry; similar styles of mineralization have been traced for upwards of 500m along strike. This mineralization displays some similarities with epithermal-related Ag-Au veining developed further to the west in the area of the Heritage prospect.

### Stop 3.3: Heritage Prospect



*Plate 14: Location reference for Stop 3.3 (UTM 583140E/5193931N).*

*From Stop 3.2, continue on route 220 to the southwest for approximately 18km until reaching the town of Calmer. The stop is located in a quarry on the right hand side of the road just past the town when driving towards the west.*

This quarry exposes both volcanoclastic and small-volume intrusive rocks mapped as members of the late Proterozoic High Beach Basalts (Marystown Group) by O'Brien *et al.* (1977). The volcanoclastic rocks show incipient evidence of later silicification, as well as interclast fillings of jasperoid silica, which strongly resemble features of the basaltic to andesitic coarse pyroclastics that are the predominant host to the epithermal Ag-Au mineralization at the Heritage Prospect to the north of the quarry.

The Heritage prospect is located to the northeast of this location, but is not accessible by road. Instead we will take the opportunity to examine select hand samples from the area which display the characteristic features associated with the Ag-Au, low-sulphidation related veining developed at the prospect.

### Stop 3.4: Rencontre Formation



*Plate 15: Location reference for Stop 3.4 (UTM 579864E/519208N).*

*From Stop 3.3, continue on route 220 to the southwest until reaching the town of Lories. Turn left onto Mick's Cove Road, then turn right at the beach front. The outcrop exposure is located along the shoreline to the left, before the pond on the opposite side of the road.*

Myrow (2017) describes the Rencontre Formation as the beginning of a terminal Ediacaran-lower Cambrian cover succession deposited along the northwestern margin of Avalonia. This long shoreline outcrop provides an excellent exposure of a predominantly siltstone facies of the Rencontre Formation, which elsewhere also includes conglomerate through sandstone lithologies (O'Brien et al, 1977; Smith and Hiscott, 1984).

### Stop 3.5: Random Formation



Plate 16: Location reference for Stop 3.5 (UTM 581461E/5203672N).

*From Stop 3.4, proceed back to route 220, turning left and continuing westward for approximately 9km. The stop is located in a quarry on the left hand side of the road.*

The Lower Cambrian Random Formation forms an extensive sheet of quartz arenite and shale extending over much of the Newfoundland Avalon Zone and is inferred to have been deposited within intertidal mud flats, subtidal sand shoals, and the muddy bottom of an open marine shelf (Hiscott, 1982). This unit represents the first truly platformal style of deposition within the Avalon Zone of Newfoundland, as it displays no relationships with any of the pre-existing late Precambrian basins within the region, extending across the previously irregular and tectonically active terrane (Smith and Hiscott, 1984).

## References

- Anderson, M.M., Bruckner, W.D., King, A.F. and Maher, J.B.  
1975: The Late Proterozoic 'H.D. Lilly Unconformity' at Red Head, northeastern Avalon Peninsula, Newfoundland. *American Journal of Science*, Volume 275, pages 1012-1027.
- Bell, K., Blenkinsop, J. and Strong, D.F.  
1977: The geochronology of some granitic bodies from eastern Newfoundland and its bearing on Appalachian evolution. *Canadian Journal of Earth Sciences*, Volume, 14, pages 456-476.
- Blackwood, R.F. and Kennedy, M.J.  
1975: The Dover Fault: Western boundary of the Avalon Zone in northeastern Newfoundland. *Canadian Journal of Earth Sciences*, Volume 12, pages 320-325.
- Candela, P.A.  
1997: A review of shallow, ore-related granites: textures, volatiles, and ore metals. *Journal of Petrology*, Volume 38, Number 12, pages 1619-1633.
- Clarke, M.  
2012: Host lithologies, breccia development, alteration and gold mineralization at the Big Easy prospect. Unpublished B.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 85 pages.
- Collins, C.J.  
1984: Genesis of the St. Lawrence fluorite deposits. In *Mineral Deposits of Newfoundland – A 1984 Perspective*. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 84-3, pages 164-170.
- Dallmeyer, R.D., Hussey, E.M., O'Brien, S.J. and O'Driscoll, C.F.  
1983: Geochronology of tectonothermal activity in the western Avalon Zone of the Newfoundland Appalachians, *Canadian Journal of Earth Sciences*, Volume 20, pages 355-363.
- Dec, T., O'Brien, S. J. and Knight, I.  
1992: Late Precambrian volcanoclastic deposits of the Avalonian Eastport basin [Newfoundland Appalachians]: petrofacies, detrital clinopyroxene geochemistry and paleotectonic implications. *Precambrian Research*, v. 59, 1992, pages 243-262.
- Dickson, W. L.  
1983: Geology, geochemistry and mineral potential of the Ackley Granite and parts of the North West Brook and Eastern Meelpaeg complexes, southeast Newfoundland.



Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-6.

Dunning, G. R., O'Brien, S. J., Colman-Sadd, S. P., Blackwood, R. F., Dickson, W. L., O'Neill, P. P. and Krogh, T. E.

1990: Silurian orogeny in the Newfoundland Appalachians. *Journal of Geology*, Volume 98, No. 6, pages 895-913.

Edwards, E.F.

1991: *Billey Spinney, The Umbrella Tree and Other Recollections of St. Lawrence*. Publisher: The Author, 80 pages.

Evans, J.L.

1977: Contact metamorphism around the St. Lawrence Granites, Burin Peninsula, Newfoundland. B.Sc. (Hons.) Thesis, Memorial University, St. John's, Newfoundland and Labrador (unpublished)

Ferguson, S.A.

2017: Late Neoproterozoic epithermal-style Au mineralization of the Burin Peninsula, Newfoundland: U-Pb geochronology and deposit characteristics. Unpublished M.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 394 pages.

Ferguson, S.A., Layne, G.D., Dunning, G.R., and Sparkes G.W.

2014, Late Neo-Proterozoic epithermal-style Au mineralization of the Burin Peninsula, Newfoundland: U-Pb geochronology and deposit characteristics, GAC-MAC Annual Meeting 2014, Abstracts with program, 91 pages.

Foley, N.K. and Ayuso, R.A.

2012: Gold deposits of the Carolina Slate Belt, southeastern United States—Age and origin of the major gold producers: U.S. Geological Survey Open-File Report 2012-1179, 26 pages.

Gagnon, J.E., Samson, I.M., Fryer, B.J. and Williams-Jones, A.E.

2003: Compositional heterogeneity in fluorite and the genesis of fluorite deposits: insights from La-ICP-MS analysis. *The Canadian Mineralogist*, Volume 41, pages 365-382.

Harris, J.

1996; First and Second year assessment report on geological and geochemical exploration for licence 4554 on claim 17112 and licence 4679 on claim block 8474 in the Henrys Pond area, eastern Newfoundland. Newfoundland and Labrador Geological Survey, Assessment File 2D/0312, 29 pages.

Hayes, A.O.

1948: Geology of the area between Bonavista and Trinity Bays, eastern Newfoundland. Newfoundland Geological Survey, Bulletin 32, pages 1-37.

Hiscott, R.N.

1982: Tidal deposits of the Lower Cambrian Random Formation, eastern Newfoundland: facies and paleoenvironments. *Canadian Journal of Earth Sciences*, Volume 19, pages 2028-2042.

Hussey, E.M.

1979: Geology of Clode Sound area, Newfoundland. M.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 312 pages.

Irving, E. and Strong, D.F.

1985: Paleomagnetism of rocks from Burin Peninsula, Newfoundland: Hypothesis of Late Paleozoic displacement of Acadia criticized. *Journal of Geophysical Research*, Volume 90, Issue B2, pages 1949-1962.

Kawasaki, K.

2011: Paleomagnetism and rock magnetism of "SEDEX" Zn-Pb-Cu ores in black shales in Australia and Yukon and of fluorite veins in granite in Newfoundland. *Electronic Theses and Dissertations*, Paper 445, 204 pages.

Kawasaki, K. and Symons, D.T.A.

2008: Paleomagnetism of fluorite veins in the Devonian St. Lawrence granite, Newfoundland, Canada. *Canadian Journal of Earth Sciences*, Volume 45, Number 1, pages 969-980.

Kellett, D.A., Rogers, N., McNicoll, V., Kerr, A. and van Staal, C.

2014: New age data refine extent and duration of Paleozoic and Neoproterozoic plutonism at Ganderia-Avalonia boundary, Newfoundland. *Canadian Journal of Earth Sciences*. Volume 51, pages 943-972.

Kennedy, M.J., Blackwood, R.F., Colman-Sadd, S.P., O'Driscoll, C.F., and Dickson, W.L.

1982: The Dover-Hermitage Bay Fault: boundary between the Gander and Avalon Zones, eastern Newfoundland. In *Major structural zones and faults of the northern Appalachians*, Edited by P. St - Julyien and J. Beland, Geological Association of Canada, Special Paper Number 24, pages 231-247.

Kerr, A., Dickson, W.L., Hayes, J.P. and Fryer, B.J.

1993a: Devonian postorogenic granites on the southeastern margin of the Newfoundland Appalachians: a review of geology, geochemistry, petrogenesis and mineral potential. In *Current Research*. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 93-1, pages 239-278.

Kerr, A. Dunning, G.R. and Tucker, R.D.

1993b: The youngest Paleozoic plutonism of the Newfoundland Appalachians: U-Pb ages from the St. Lawrence and François granites. *Canadian Journal of Earth Sciences*, Volume 30, pages 2328-2333.

Kontak, D.J., Tuach, J., Strong, D.F., Archibald, D.A. and Farrar, E.

- 1988: Plutonic and hydrothermal events in the Ackley Granite, southeast Newfoundland, as indicated by total-fusion  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronology. *Canadian Journal of Earth Sciences*, Volume 25, pages 1151-1160.
- Knight, I. and O'Brien, S. J.
- 1988: Stratigraphy and sedimentology of the Connecting Point Group and related rocks, Bonavista Bay, Newfoundland: an example of a Late Precambrian Avalonian basin. *In Current Research. Newfoundland and Labrador, Department of Mines, Mineral Development Division, Report 88-01, 1988, pages 207-228.*
- Magyarosi, Z.
- 2018: Preliminary investigations of the fluorite mineralization in the sediment- and rhyolite-hosted AGS vein system, St. Lawrence, Newfoundland. *In Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 18-1, pages 95-121.*
- Meyer, J., Tomlin, S. and Green, R.
- 1984: Mineral occurrence map, Gander Lake, Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Map 84-045.
- O'Brien, S.J.
- 2002: A note on Neoproterozoic gold, early Paleozoic copper and basement-cover relationships on the margins of the Holyrood Horst, southeastern Newfoundland. *In Current research, Edited by C. P. G. Pereira and D. G. Walsh, Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 2-1, pages 219-227.*
- 1993: A preliminary account of geological investigations in the Clode Sound-Goose Bay region, Bonavista Bay, Newfoundland [NTS 2C5/NW and 2D8/NE]. *In Current research, Edited by C. P. G. Pereira, D. G. Walsh and R. F. Blackwood, Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report 93-01, pages 293-309.*
- 1987: Geology of the Eastport (west half) map area, Bonavista Bay, Newfoundland. *In Current Research, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1: pages 257-270.*
- O'Brien, S. J. and Holdsworth, R. E.
- 1992: Geological development of the Avalon Zone, the easternmost Gander Zone, and the ductile Dover Fault in the Glovertown [NTS 2D/9, east half] map area, eastern Newfoundland. *In Current Research. Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report 92-01, pages 171-184.*
- O'Brien, S.J. and Knight, I.
- 1988: The Avalonian geology of southwest Bonavista Bay: portions of the St Brendans [2C/13] and Eastport [2C/12] map areas. *In Current research, Edited by R. S. Hyde, D. G. Walsh and R. F. Blackwood, Government of Newfoundland and Labrador, Department of Mines, Mineral Development Division, Report 88-01, pages 193-205.*
- O'Brien, S.J. and Taylor, S.W.

- 1983: Geology of the Baine Harbour (1M/7) and point Enragee (1M/6) map areas, southeastern Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-5, 70 pages.
- O'Brien, S. J., Dube, B. and O'Driscoll, C. F.
- 2001: Epithermal-style hydrothermal systems in Late Neoproterozoic Avalonian rocks on the Avalon Peninsula, Newfoundland: Implication for gold exploration. Geological Association of Canada-Mineralogical Association of Canada, Field Trip Guidebook A6, 2001, 34 pages.
- O'Brien, S. J., Dubé, B. and O'Driscoll, C. F.
- 1999: High-sulphidation, epithermal-style hydrothermal systems in late Neoproterozoic Avalonian rocks on the Burin Peninsula, Newfoundland: implications for gold exploration. *In* Current Research. Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 99-01, pages 275-296.
- O'Brien, S. J., Dubé, B., O'Driscoll, C. F. and Mills, J.
- 1998: Geological setting of gold mineralization and related hydrothermal alteration in late Neoproterozoic [post-640 Ma] Avalonian rocks of Newfoundland, with a review of coeval gold deposits elsewhere in the Appalachian Avalonian belt. *In* Current Research. Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 98-01, pages 93-124.
- O'Brien, S. J., Dunning, G. R., Knight, I. and Dec, T.
- 1989: Late Precambrian geology of the north shore of Bonavista Bay [Clode Sound to Lockers Bay]. *In* Report of activities 1989, *Compiled by* C. P. G. Pereira and D. G. Walsh, Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report of Activities, pages 49-50.
- O'Brien, S.J., Nunn, G.A.G., Dickson, W.L. and Tuach, J.
- 1984: geology of the Terrenceville (1M/10) and Gisborne Lake (1M/15) map areas, southeast Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-4, 54 pages.
- O'Brien, S.J., O'Brien, B.H., Dunning, G.R. and Tucker, R.D.
- 1996: Late Neoproterozoic evolution of Avalonian and associated peri-Gondwanan rocks of the Newfoundland Appalachians. *In*: Avalonian and Related Terranes of the Circum-North Atlantic. Edited by M.D. Thompson and R.D. Nance. Geological Society of America, Special Paper 304, pages 9-28.
- O'Brien, S. J., O'Brien, B. H., O'Driscoll, C.F., Dunning, G.R., Holdsworth, R.E. and Tucker, R.
- 1991: Silurian orogenesis and the northwestern limit of Avalonian rocks in the Hermitage Flexure, Newfoundland Appalachians. Geological Society of America Abstracts with Programs, Volume 23, No. 1, page 109.
- O'Brien, S. J., O'Driscoll, C. F., Greene, B. A. and Tucker, R. D.
- 1995: Pre-carboniferous geology of the Connaigre Peninsula and the adjacent coast of Fortune Bay, southern Newfoundland. *In* Current Research. Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Report 95-01, pages 267-297.
- O'Brien, S. J., O'Driscoll, C. F., Tucker, R. D. and Dunning, G. R.

- 1994: *In* Report of activities 1994, *Edited by* C. P. G. Pereira, Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey Branch, Report of Activities, pages 77-81.
- O'Brien, S. J., Strong, D. F. and King, A. F.  
 1990: The Avalon Zone type area: southeastern Newfoundland Appalachians. *In* Avalonian and Cadomian geology of the North Atlantic, *Edited by* R. A. Strachan and G. K. Taylor, pages 166-194.
- O'Brien, S.J., Strong, P.G. and Evans, J.L.  
 1977: Geology of the Grand Bank (1M/4) and Lamaline (1L/13) map areas, Newfoundland; Newfoundland Department of Mines and Energy, Mineral Development Division, Report 77-7.
- O'Brien, S.J., Tucker, R.D., Dunning, G.R. and O'Driscoll, C.F.  
 1992: Four-fold subdivision of the Late Precambrian magmatic record of the Avalon Zone type area (East Newfoundland): Nature and significance. Geological Association of Canada Abstracts with Program, Annual Meeting, Volume 17, page A85
- Prince, J.M.  
 2009, Petrography, geochemistry of a granite related silty limestone Zn, Pb skarn deposit, Lawn, Newfoundland. Unpublished Honors Dissertation (B.Sc.), Memorial University of Newfoundland, St. John's, Newfoundland, 69 pages.
- Reeves, J.H., Sparkes, B.A. and Wilson, N.  
 2016: Paragenesis of fluorspar deposits on the southern Burin Peninsula, Newfoundland, Canada. Canadian Institute of Mining Journal, Volume 7, Number 2, pages 77-86.
- Richardson, C.K. and Holland, H.D.  
 1979: Fluorite deposition in hydrothermal systems. *Geochimica et Cosmochimica Acta*, Volume 43, pages 1327-1335.
- Smith, W.S.  
 1957: Fluorspar at St. Lawrence, Newfoundland. Newfoundland Fluorspar Limited, Assessment Report (001L/0016).
- Smith, S.A. and Hiscott, R.N.  
 1984: Latest Precambrian to Early Cambrian basin evolution, Fortune Bay, Newfoundland: fault-bounded basin to platform. *Canadian Journal of Earth Sciences*, Volume 21, Number 12, pages 1379-1392.
- Sparkes, B.A. and Reeves, J.R.  
 2015: AGS Project, project review and resource estimate, Canada Fluorspar Inc. Presentation, Baie Verte Mining Conference.
- Sparkes, G. W  
 2012: New developments concerning epithermal alteration and related mineralization along the western margin of the Avalon Zone, Newfoundland. *In* Current Research. Newfoundland and Labrador, Department of Natural Resources, Mines Branch, Report 12-1, 2012, pages 103-120.
- Sparkes, G.W., O'Brien, S.J., Dunning, G.R. and Dubé, B.

- 2005: U-Pb geochronological constraints on the timing of magmatism, epithermal alteration and low-sulphidation gold mineralization, eastern Avalon Zone, Newfoundland. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey, Report 05-1, pages 115-130.
- Strong, D.F.  
1982: Carbothermal metasomatism of alaskitic granite, St. Lawrence, Newfoundland, Canada. *Chemical Geology*, Volume 35, pages 97-114.
- Strong, D.F., Fryer, B.J. and Kerrich, R.  
1984: Genesis of the St. Lawrence fluorspar deposits as indicated by fluid inclusion, rare earth element, and isotopic data. *Economic Geology*, Volume 79, pages 1142-1158.
- Strong, D.F. O'Brien, S.J., Taylor, S.W., Strong, P.G. and Wilton, D.H.  
1978a: Geology of Marystown (1M/3 and St. Lawrence 1L/14) map areas, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 77-8, 81 pages.
- Strong, D.F. O'Brien, S.J., Taylor, S.W., Strong, P.G. and Wilton, D.H.  
1978b: Aborted Proterozoic rifting in eastern Newfoundland. *Canadian Journal of Earth Sciences*, Volume 15, pages 117-131.
- Teng, H.C.  
1974: A lithogeochemical study of the St. Lawrence Granite, Newfoundland. Unpublished M.Sc. thesis, Memorial University of Newfoundland, 194 pages.
- Teng, H.C. and Strong, D.F.  
1976: Geology and geochemistry of the St. Lawrence peralkaline granite and associated fluorite deposits, southeast Newfoundland. *Canadian Journal of Earth Sciences*, Volume 13, pages 1374-1385.
- Tuach, J  
1991: The geology and geochemistry of the Cross Hills Plutonic Suite, Fortune Bay, Newfoundland [NTS 1M/10], an Eocambrian to Cambrian alkaline gabbro-granodiorite-granite-peralkaline granite-syenite suite containing minor Zr-Y-Nb-REE mineralization. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Report 91-02, 86 pages.
- 1987: The Ackley high-silica magmatic –metallogenic system and associated post-tectonic granites, SE Newfoundland. Unpublished Ph. D. thesis, Memorial University of Newfoundland, St. John's, Newfoundland.
- Tuach, J., Davenport, P.H., Dickson, W. L. and Strong, D.F.  
1986: Geochemical trends in the Ackley Granite, southeast Newfoundland: their relevance to magmatic –metallogenic processes in high-silica granitoid systems. *Canadian Journal of Earth Sciences*, Volume 23, pages 747-765.
- Van Alstine, R.E.  
1948: Geology and mineral deposits of the St. Lawrence area, Burin Peninsula, Newfoundland. Newfoundland Geological Survey, Bulletin Number 23, 73 pages.

Van Alstine, R.E.

1976: Continental rifts and lineaments associated with major fluorspar districts. *Economic Geology*, Volume 71, pages 977-987.

van Staal, C.R.

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

Widmer, K.

1950: The geology of the Hermitage Bay area, Newfoundland. Ph. D. thesis, Princeton, New Jersey, Princeton University, 439 pages.

Williams, H.

1979: Appalachian Orogen in Canada, *Canadian Journal of Earth Sciences*, Volume 16, pages 792-807.

Williamson, D.H.

1956: The geology of the fluorspar district of St. Lawrence, Burin Peninsula, Newfoundland. Government of Newfoundland and Labrador, Department of Mines, Agriculture and Resources, Unpublished report, 140 pages.

Wilson, N.

2000: Fluorspar, a guide to the mineral, veins and occurrences of the southern Burin Peninsula, Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Special Report, NFLD 3020, 142 pages.

Younce, G.B.

1970: Structural geology and stratigraphy of the Bonavista Bay region, Newfoundland. Ph. D. thesis, Ithaca, New York, Cornell University, 188 pages.