GEOLOGICAL SURVEY OF NEWFOUNDLAND AND LABRADOR

Project Summaries 2017

Newfoundland Labrador

Natural Resources

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PROJECT SUMMARIES 2017

NATURAL RESOURCES

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Preface

The province is fortunate in possessing a remarkable and varied geology; the rocks represent a long and complicated history, and are the source of many raw materials that are vital to its economic future and well-being. Also, in recent time, Earth hazards have proven to be harmful to life, and detrimental to the community economic infrastructure; these need to be addressed. A relatively new pursuit for the Geological Survey is supporting Geotourism, and Global Geoparks. These are co-operative programs that include the community, developing local cultural identities that protect and celebrate the land.

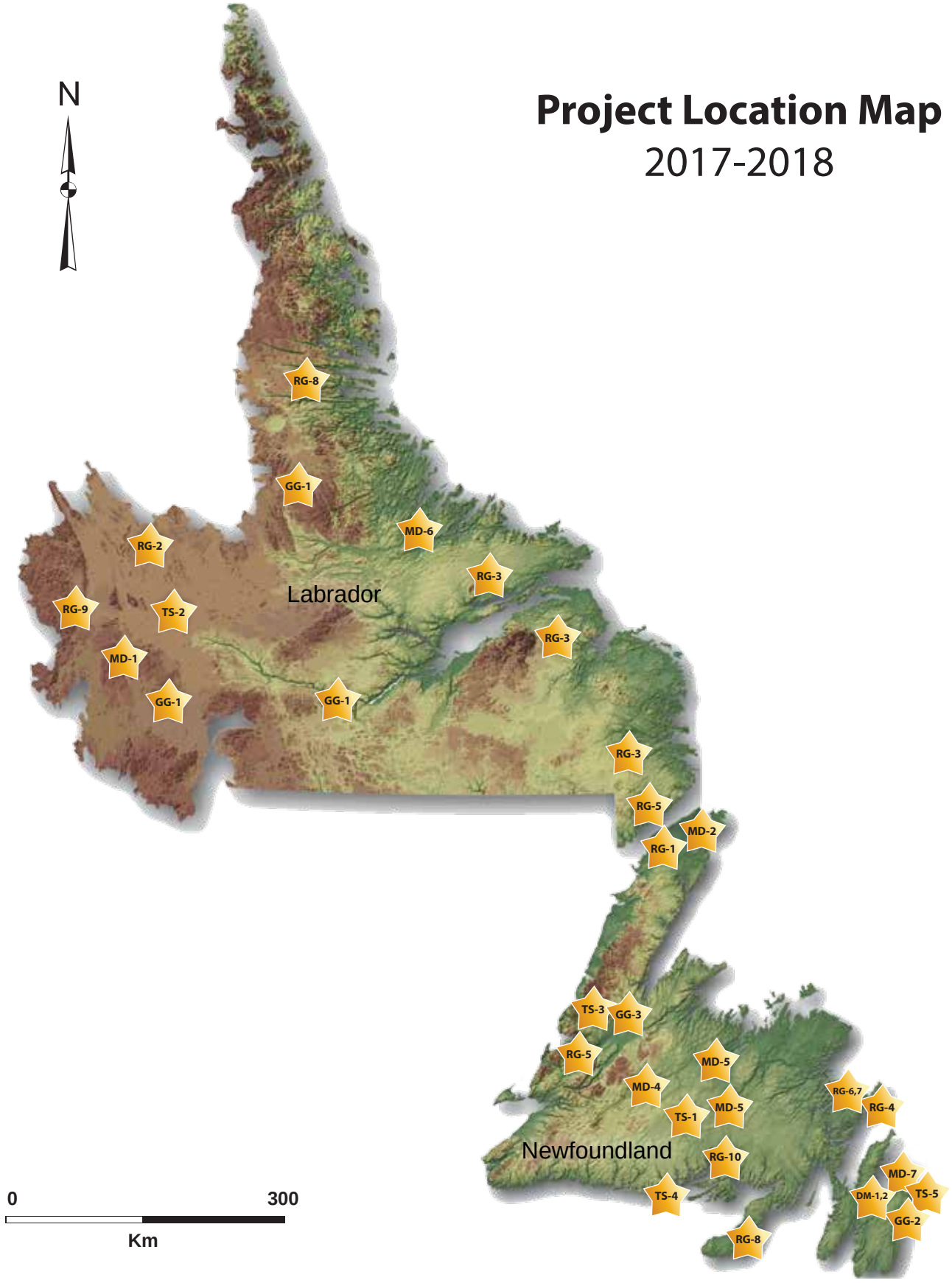
The Geological Survey conducts extensive field programs throughout the province that addresses the many issues noted above. These programs are partly determined by long-range planning to fulfil departmental requirements, and partly a response to directions and advice from external client groups (prospectors/government/academia). Ongoing economic geology programs were/or will be pursued in the Great Northern Peninsula, southern Newfoundland and Western Labrador. Regional mapping programs were focused on the Bonavista Peninsula, southern Newfoundland, southern Labrador and northern Newfoundland. Terrain sciences and till-geochemistry projects were conducted in both western Labrador and central Newfoundland.

The reports in this publication, reflect annual year-end activities of on-going projects, end-of-project reports, and information on programs about to commence during the upcoming 2017 field season. These reports have been written in layman's English and are for general distribution, and available through the Geological Survey website. Illustrations within each report reflect the many aspects of field work and field working conditions. Also illustrated are examples of representative mineralised rock types, digital data presentations.

Clients and client groups looking for detailed information are initially directed to the section **Outcomes -** at the bottom of each project summary. Our geoscientists can be contacted for any additional information, and, as always, I am available to discuss the programs and projects of the Geological Survey.

Martin Batterson
Director

Project Location Map
2017-2018



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MD-1 Examination of Iron Formation Drillcore from the Gabbro Lake Area, Western Labrador

James Conliffe

The iron-ore deposits of western Labrador have been mined since the 1950s, and are a major contributor to the provincial economy. These deposits formed about 1.8 billion years ago, as iron sediments and were deposited in a large ocean basin. However, other than studies in areas of active mining, close to Labrador City/Wabush and Schefferville, little is known about the geology or economic potential for iron outside of these areas. A better understanding of the depositional processes of iron formations across the Labrador Trough is important in determining the economic potential of these areas.

In 2014, research in the Gabbro Lake area, along the eastern margin of the Labrador Trough, looked at some of these depositional processes. Previous studies have been hampered due to the thick blanket of sediments deposited by glaciers and the lack of rock exposure. Earlier, in 2012, exploration drilling intercepted thick sequences of iron sediments, and the current study thoroughly examines the recovered drillcore. Representative samples from the drillcore were also selected for laboratory analyses.

Early studies have shown that the iron in the Schefferville area was deposited in shallow waters close to the shore. In contrast, this study shows the deposition in the Gabbro Lake area was in relatively deeper water, closer to the continental shelf edge. The iron formation mainly consists of bands, rich in iron minerals and silica (called banded-iron formation), which were heated and folded during two mountain building events (lasting tens of millions of years). This area was also subjected to multiple volcanic events, and beds of volcanic ash are common. These findings have important implications for future exploration in the area, as the characteristics of the iron formations affects how a suitable ore-grade material can be produced.

Outcomes

- Conliffe, J., 2017: Geology and Geochemistry of the Sokoman Formation in the Gabbro Lake Area, Eastern Labrador Trough. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 17-1, pages 147-168.
- Compilation of geochemical data from the eastern Labrador Trough (for publication in Open File Report, 2017).
- The presence of significant thicknesses of iron formations in the eastern Labrador Trough shows the mineral potential of this area. However, given the differences between iron formation in this area and that in the areas of current mining, more geological and metallurgical work is needed to determine if economic iron-ore deposits occur in the eastern Labrador Trough.

Iron formation consisting of bands, rich in iron minerals and silica.

MD-2 Zn-mineralization on the Great Northern Peninsula, Newfoundland

*James Conliffe and *Robert King*

In 2016, the Geological Survey started a new project investigating the exploration potential for zinc mineralization on the Great Northern Peninsula. Numerous zinc occurrences have been reported, including the Daniels Harbour Deposit (the former Newfoundland Zinc Mine; operational between 1975 and 1990), as well as the Round Pond deposit, and Salmon River and Twin Ponds prospects in the Hare Bay and Pistolet Bay areas. These occurrences represent Mississippi Valley-Type (MVT) deposits, which account for a large proportion of global zinc production.

Around 480-million years ago, the limestones and dolomites of western Newfoundland were deposited in a shallow tropical sea. During the formation of the Appalachian mountain range, these rocks were buried and deformed, and warm metal-bearing water flowed through them forming MVT deposits, where zinc minerals (sphalerite) crystallized along fractures in the rocks, replacing the host dolomite. However, these deposits are generally small and can be difficult to find, hence detailed geological knowledge is needed to locate new orebodies, particularly 'blind' orebodies that are not exposed at the surface.

The objectives are to determine how, why, and where these deposits form. Fieldwork included visits to all the major zinc occurrences in western Newfoundland that have rock exposures mapped, and samples collected for laboratory analysis. This work has identified two main types of deposit, and shown that large areas of the Northern Peninsula have exploration potential.

Ongoing research at Memorial University and at the Geological Survey aims to better understand the processes involved in forming these deposits, which, in turn, will help develop better exploration models for the discovery of new orebodies.

Outcomes

- King, R. and Conliffe, J., 2017: Carbonate-hosted Zn mineralization in the Hare Bay and Pistolet Bay areas, Great Northern Peninsula, Newfoundland. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 17-1, pages 169-187.

- King, R., 2017: Zn (±Pb) Mineralization on the Great Northern Peninsula, Western Newfoundland. Unpublished B.Sc. thesis, Memorial University of Newfoundland.

- Compilation of geochemical and isotopic data from Zn-Pb occurrences on the Great Northern Peninsula (for publication in Open File Report, 2017).

- Identification of significant zinc mineralization and prospective rock types over more than 60 km from Pistolet Bay to Main Brook, show the high mineral potential of the Great Northern Peninsula.

** Department of Earth Sciences, Memorial University of Newfoundland, St. John's.*

MD-3 Base-metal Potential of the North Steady Pond Formation, Central Newfoundland

John Hinchey

The volcanic rocks of the North Steady Pond Formation (Baie d'Espoir Group) have potential to host base-metal (copper-lead-zinc) mineralization, as exemplified by the Katie volcanogenic massive sulphide (VMS) occurrence, and many other smaller mineral occurrences. However, much of the study area is inaccessible or is covered by thick glacial deposits, hampering exploration.

In 2016, research focused on petrographic (rock texture and minerals), lithogeochemical (rock chemistry), and geochronological (age/date of the rocks) studies of samples from the formation to support exploration efforts, and to assess the broader potential of this region for base-metal mineralization. The goal of the research is to document the styles of VMS mineralization, to characterize the host rocks, and to add to the tectonostratigraphic (geological and structural) understanding of the area.

Polished slab exemplifying copper-lead-zinc mineralization; volcanogenic massive sulphide (VMS) occurrence.

Outcomes

- New alteration zones that have anomalous base-metal mineralization were discovered in the western North Steady Pond Formation. These zones display similar alteration styles as those associated with the Katie VMS occurrence to the east.

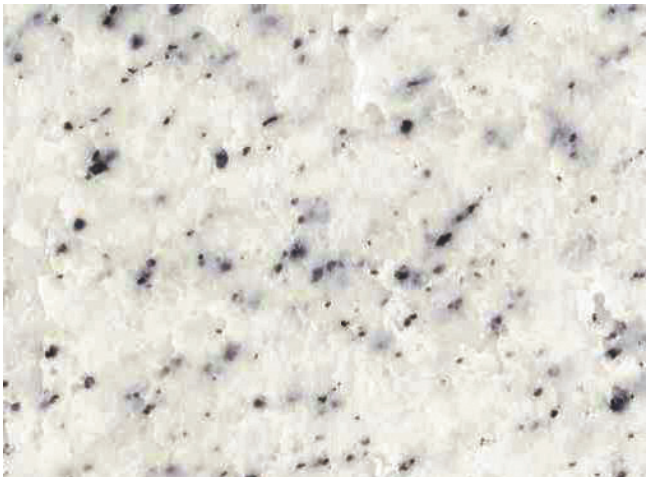
- Lithogeochemical studies indicate that there are two groups of felsic rocks in the vicinity of the Katie VMS occurrence. The first group is composed of felsic tuff and quartz-feldspar porphyry and represents the host rocks of the Katie occurrence. The second group is composed of leucocratic, quartz-feldspar trondhjemite that resembles rocks associated with the older Coy Pond Ophiolite Complex. These results have implications for the tectonostratigraphic architecture of the area, and hence the exploration potential of the area.

- Geochronological studies on the quartz-phyric felsic volcanic rock that hosts the Katie VMS occurrence returned an age of 471.1 +/- 1.4 Ma, similar to previously published ages from the Baie d'Espoir Group.

MD-4 Industrial Mineral Studies, Newfoundland and Labrador

Zsuzsanna Magyarosi

Fluorite vein from St. Lawrence



Polished white, graphitic marble from Coal Brook, SW Newfoundland

Industrial minerals play a significant role in the mining and exploration industry of Newfoundland and Labrador. They include any rock and mineral of economic value excluding metallic minerals, mineral fuels and gemstones. The main uses of industrial minerals include construction materials (building stone, brick and cement), chemical applications (environmental and agricultural uses, cosmetics) and manufacturing processes (metallurgical uses, glass, drilling), the list of applications is endless.

Fluorite in the St. Lawrence area, Burin Peninsula, has been known since 1825 and is one of the world's largest fluorite deposits. It was mined intermittently between 1933 and 1991. Canada Fluorspar Inc. has been actively exploring the deposit and has plans to reopen the mine in the near future.

Building stones with economic potential include slate, sandstone, labradorite, gabbro, granite, marble and soapstone. Currently, there are several active sandstone quarries in the Corner Brook area and on Bell Island. Slate has been quarried from the Bonavista Peninsula and Labradorite has been extracted from Ten Mile Bay and Tabor Island in northern Labrador. Both granite and gabbro have been quarried in the past from central Newfoundland with some significant resources still remaining. Large amounts of high-quality marble occur in western Newfoundland.

Pyrophyllite in Manuels, just outside of St. John's, has been known since 1902 and mined since 1904. Currently, Trinity Resources operates the pyrophyllite mine.

Barite is mined as a by-product from the former producing Cu-Zn-Pb deposits at Buchans. Barite veins occur in eastern Newfoundland at Collier Point, La Manche, in the St. Bride's area and the St. Lawrence area.

There has been significant exploration for rare-earth elements (REE., such as scandium, yttrium, lanthanum) in Labrador in recent years. The Strange Lake deposit in northwestern Labrador is the largest known REE deposit in the province; however it is located within exempt mineral lands. Between 2009 and 2011 Search Minerals Ltd., identified three other significant REE districts in Labrador: Port Hope Simpson Cree, Henley Harbour and Red Wine Complex.

Silica occurrences are well known both in Newfoundland and Labrador. In Labrador, the Wabush area hosts several silica deposits. The most promising prospect in Newfoundland is La Scie, which is composed of very pure quartz in a vein.

Other industrial minerals include limestone and dolostone on the west coast of Newfoundland; salt, potash and gypsum in the Stephenville area; peat in central Newfoundland, and refractories throughout the province.

There has been a hiatus in industrial mineral research in the Geological Survey for over a decade. This year work will concentrate on: i) updating and promoting information on industrial minerals, ii) conducting field work and research on recent discoveries to understand the geology of the deposits in order to explore for similar resources, and iii) exploring for industrial minerals previously not identified in the province such as lithium.

Outcomes

- Publicly available updated information on industrial minerals.
- New data on recent industrial mineral discoveries.
- Exploration tools to locate industrial minerals previously not identified in the province, such as lithium.

MD-5 Investigation into Gold-Silver-Antimony Mineralization in the Mount Peyton Area (West of Glenwood)

Hamish Sandeman

The region lying to the west of Glenwood and northwestward to the Notre Dame Junction has been of interest for gold, silver and antimony exploration since the late 1980s. Since that time, exploration has continued sporadically with a few new discoveries by Newfoundland prospectors and exploration companies who have outlined a 13-km-long "mineralized trend" containing at least four gold-bearing zones. These include: the Hurricane-Corsair prospects and associated mineralization; the Slip showing; the SS zone and; the Yellow Fox showing. Much of the area of interest is relatively inaccessible and is covered by thick glacial deposits making exploration for mineralization difficult. In order to support exploration efforts and to assess the broader potential of this region for such mineralization, this project was initiated in 2015 and incorporates new bedrock mapping, examination of exploration drillcore and a variety of follow-up laboratory investigations. Through combining existing industry data with new observations and analyses, the goal is to establish a testable geological model for the origin of the gold-bearing zones and to provide the exploration industry with appropriate criteria that may be used to explore more efficiently for comparable deposits.

Outcomes

• Sandeman, H.A.I., Dunning, G.R., McCullough C.K. and Peddle, C., 2017: U-Pb geochronology, petrogenetic relationships and intrusion-related precious-metal mineralization in the northern Mount Peyton intrusive suite: Implications for the origin of the Mount Peyton trend, central Newfoundland (NTS 2D/04). *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 17-1, pages 189-217.

• The mineralized zones at the 4 localities exhibit similar metal associations and mineralization styles illustrating and confirming the high mineral potential of this area.

• The recently discovered fourth zone (Yellow Fox) extends the potential mineralized corridor another 4 km to the south.

• Field observations indicate mineralization is controlled by the apparent intersection of northeast-oriented fracture systems and northwest-oriented granite intrusions.

• The maximum age of the mineralization is constrained by U-Pb geochronology to the Late Silurian (418 Ma).

Quartz veining and sericite-quartz-sulphide alteration in drillcore, Hurricane prospect.

MD-6 Mineral Deposit Studies Related to Uranium Mineralization

Greg W. Sparkes

The Central Mineral Belt of Labrador is host to a number of uranium deposits. During 2015, as part of recent investigations into the styles of uranium mineralization developed within this region, a detailed mapping and geochemical sampling program was conducted in the area of the Michelin deposit. The overall goal of this study was aimed at outlining the surface distribution of the alteration related to the development of uranium mineralization in the area. In addition, samples of drillcore were collected for age dating to better constrain the timing of events related to the formation of the deposit.

The resultant geochemical data obtained from surface samples have identified areas of sodic alteration accompanied by anomalous uranium enrichment. Also, detailed mapping of outcrops around the Michelin deposit has identified several zones of brecciation inferred to be related to the development of the overall mineralizing system. Such features are characteristic of albite-type uranium mineralization, which is more commonly developed in the Baltic Shield region, central Ukraine, and Brazil.

Results from age dating of rock units within the deposit have identified the presence of a previously unrecognized intrusive event within the host volcanic sequence, in addition to providing evidence for several periods of metamorphism and deformation within the area. The information generated as part of this study provides further insight into the distribution and timing of uranium mineralization and could potentially aid future mineral exploration in the region.

Outcomes

- Sparkes, G.W. 2017: Uranium mineralization within the Central Mineral Belt of Labrador: A summary of the diverse styles, settings and timing of mineralization. Newfoundland and Labrador Department of Natural Resources, Geological Survey. Open File Lab/1684, 173 pages.

- Sparkes, G.W., Dunning, G.R., and Langille, A. 2017: The Michelin deposit: An example of albitite-hosted uranium mineralization within the Central Mineral Belt of Labrador. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey. Report 17-1, pages 219-238.

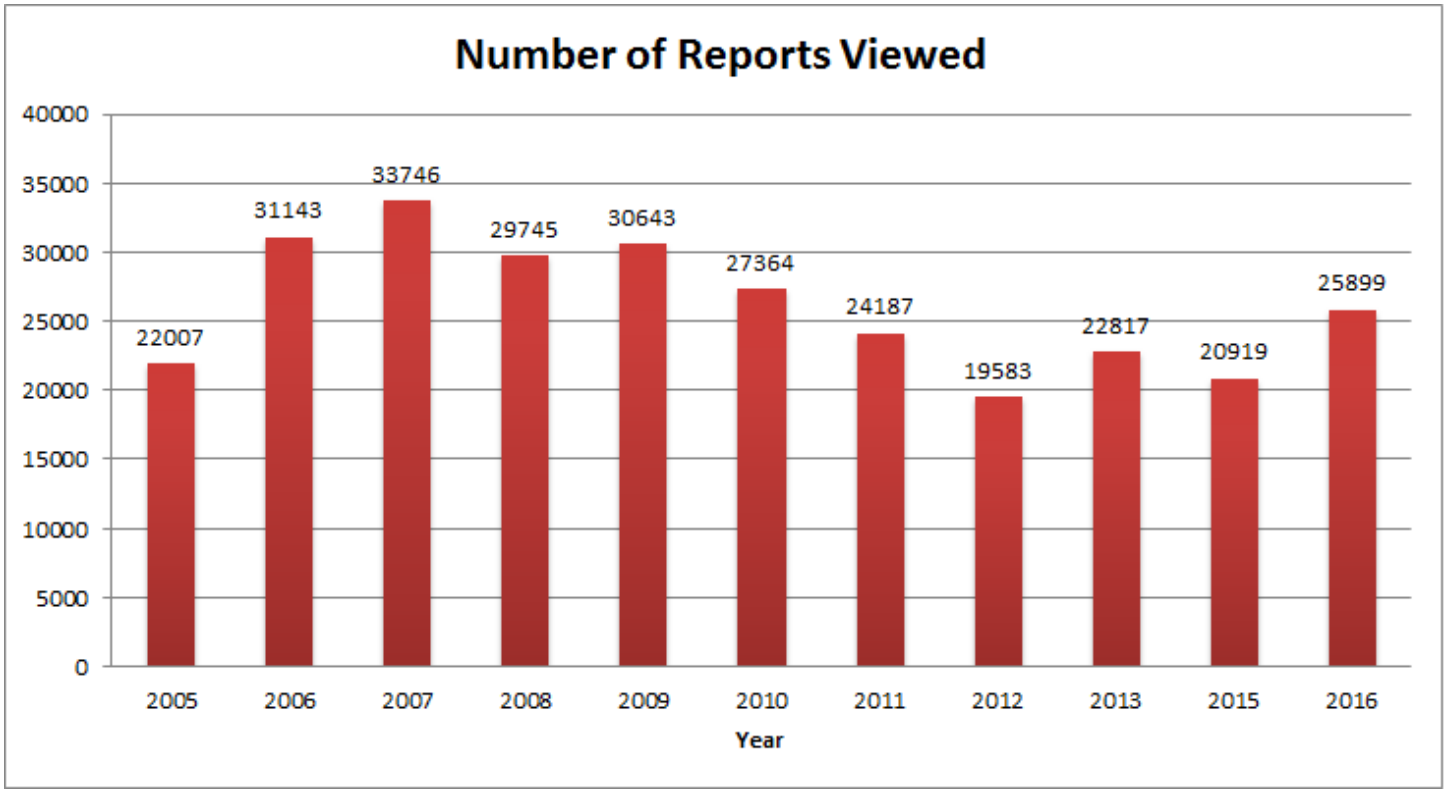
MD-7 Mineral Inventory Project

Greg J. Stapleton and Jan L. Smith

The Mineral Inventory Project is the principal repository for geological information on the Province's mineral resources and consists of a digital mineral inventory database called the Mineral Occurrence Data System (MODS), and a collection of mineral occurrence maps. The MODS currently contains approximately 7000 individual mineral inventory records with each record containing summary data including location, geological descriptions, mineralogy, deposit type, work histories, resource and/or reserve statistics, analytical results and a bibliography. It is an important mineral exploration and research tool that offers fast and easy access to mineral occurrence data covering all of Newfoundland and Labrador. The main delivery point for the MODS is the Geological Survey of Newfoundland and Labrador website (www.nr.gov.nl.ca/nr/mines/Geoscience/index.html).

The MODS provides users with a current, high-quality, online mineral deposit database that helps define the Province's mineral potential and increase its prospectivity. It is used extensively by mineral explorationists to help guide their exploration programs. It is also important in land-use planning. All provincial government land-use applications and environmental assessment projects are reviewed with the aim of minimizing the impact of land development on the Province's documented mineral resources and areas of high-mineral potential. The data generated by the Mineral Inventory Project contributes toward long-term benefits evidenced by increased investment in the provincial mineral exploration and mining industries.

The 2016 web server statistics for the MODS indicate that it was accessed 25 899 times, representing an increase of approximately 24% over 2015, and during the past ten years, it has been consistently used, averaging 26 215 hits per year. A hit is logged when the user opens a mineral inventory record.



RG-1 Trilobites of the Forteau Formation

W. Douglas Boyce

Until the latter half of the twentieth century, little paleontological work had been done in Newfoundland and Labrador. The lack of local expertise meant that the bulk of significant pre-Confederation fossil discoveries were made by outside researchers. Southern Labrador and the Great Northern Peninsula expose significant sections of the poorly understood Early Cambrian Forteau Formation: a succession of shale, limestone, siltstone and sandstone. It hosts a macrofauna of reef-building marine organisms, articulate and inarticulate brachiopods, molluscs and trilobites, amongst other less well known taxa. Originally documented in the 1860s — from only the lowest 25 m of the 100+ m thick formation — the trilobite fauna is one of the richest in eastern North America. A modern knowledge of the biostratigraphy is essential for improved regional and international correlations.

Since 1976, at least 224 fossiliferous samples have been collected from a variety of coeval type and reference sections through the Forteau Formation, as part of detailed co-operative litho- and biostratigraphic studies. Beginning in 2007, a subset of these sections was investigated in Labrador and in Newfoundland — along the Big East River logging access roads, at Mount St. Margaret quarry, and in various Route 432 (Roddickton Road) sections. During the study, many of the earlier known trilobite species were found to range much higher in the formation. Additionally, some species previously known from outside the province were newly recognized here, and one new species was discovered.

Outcomes

- Discovered new species of *Bonnia* in the Upper limestone.
- Documented a shallow-water *Bonnia—Elliptocephala* biofacies and a deeper water *Olenellus* biofacies.
- Correlated the trilobite fauna of the Forteau Formation with that of the medial *Bonnia—Olenellus* Zone of the Sekwi Formation (Mackenzie Mountains, Yukon Territory), based on the mutual occurrence of *Elliptocephala logani* (Walcott, 1910).
- Demonstrated a correlation with the *Bristolia mohavensis* Zone of the Great Basin, USA, based on the discovery of probable *Bristolia mohavensis* (Crickmay in Hazzard and Crickmay, 1933) — previously not known from NL — in the Upper limestone.

- Boyce, W.D., 2005: Calibration of the Early to Middle Cambrian Hawke Bay Event, Great Northern Peninsula, western Newfoundland, Canada. *In* Abstracts from the Joint Proceedings of the 6th British Columbia Paleontological Symposium and the Canadian Paleontology Conference 2005. Canadian Paleontology Conference Proceedings, Number 3.
- Boyce, W.D. and Knight, I., 2016: Significant New Cambrian (Dyeran to Topazan) trilobite faunas of the Labrador Group, Gros Morne National Park, western Newfoundland, Canada. *In* Geological Association of Canada, Newfoundland and Labrador Section, Annual Technical Meeting, (February 22-23, 2016, Johnson GEO CENTRE, St. John's, Newfoundland and Labrador), pages 13-14. http://www.stjohns2012.ca/GAC_NL_Section/GAC_2016_Abstracts.htm

RG-2 Regional Mapping of the Hollinger Lake Area, Western Labrador (NTS Map Sheet 23J/16)

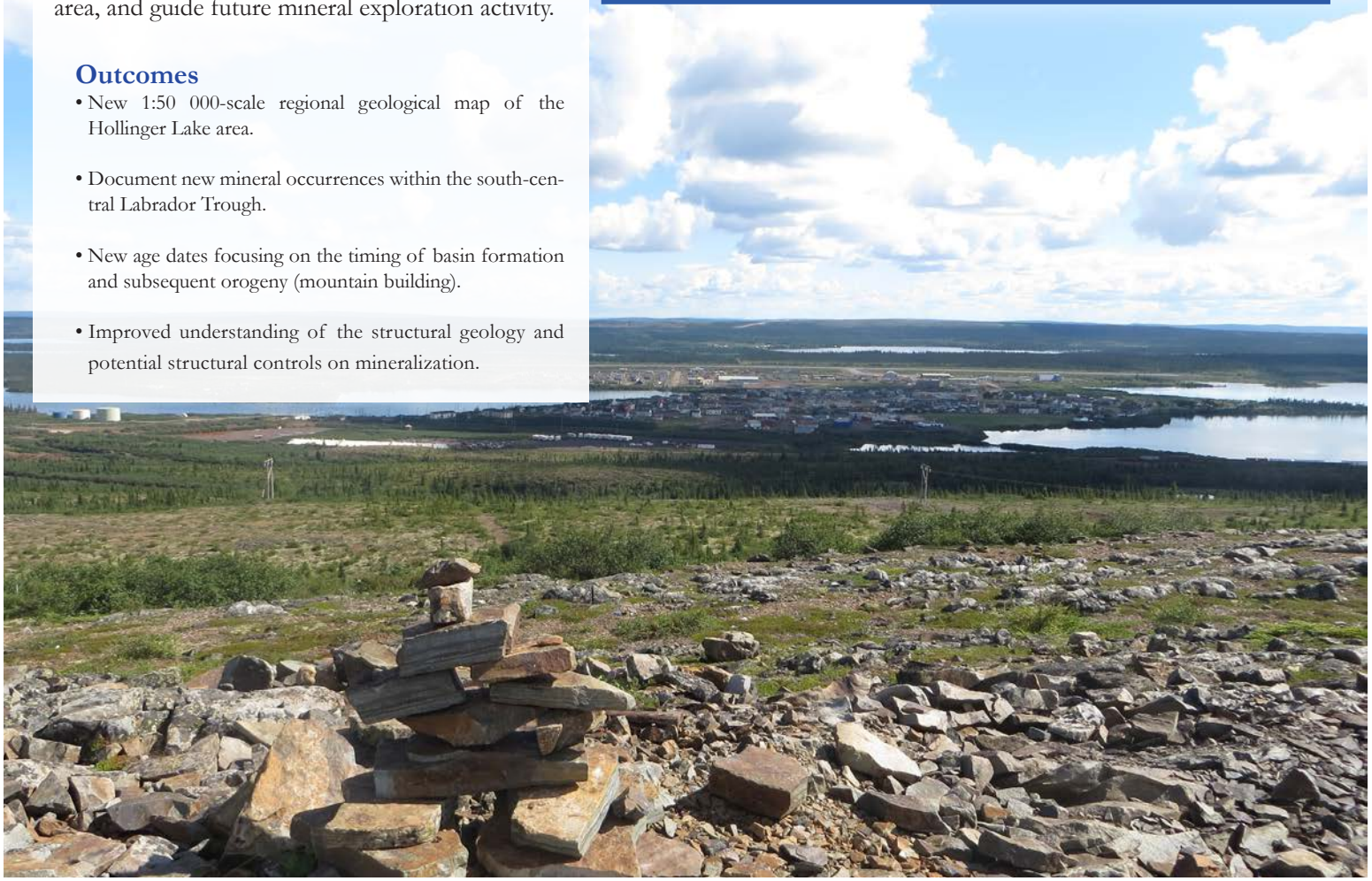
Jared P. Butler

The Hollinger Lake area lies within the south-central Labrador Trough, the eroded remnants of an ancient mountain belt extending from Ungava Bay southward to near the Gulf of St. Lawrence. The bedrock geology of the area is dominated by Paleoproterozoic (2.17 to 1.87 Ga) sedimentary and volcanic rocks deposited along the eastern margin of the Superior Craton during its initial rifting and subsequent drift, and later deformed (folded and faulted) during an episode of continental collision analogous to that which formed the present-day Himalayan mountain range. Previous mapping and recent geophysical data suggest that the area contains bedrock correlative with economically important iron deposits in the nearby Schefferville area.

Beginning in the summer of 2017, the Geological Survey will undertake new regional 1:50 000-scale bedrock mapping near Hollinger Lake, with the aim of providing innovative constraints on the distribution, structure, age, and geochemistry of bedrock that underlies the area. These new data will inform models for the tectonic evolution of the Labrador Trough, evaluate the economic potential of the area, and guide future mineral exploration activity.

Outcomes

- New 1:50 000-scale regional geological map of the Hollinger Lake area.
- Document new mineral occurrences within the south-central Labrador Trough.
- New age dates focusing on the timing of basin formation and subsequent orogeny (mountain building).
- Improved understanding of the structural geology and potential structural controls on mineralization.



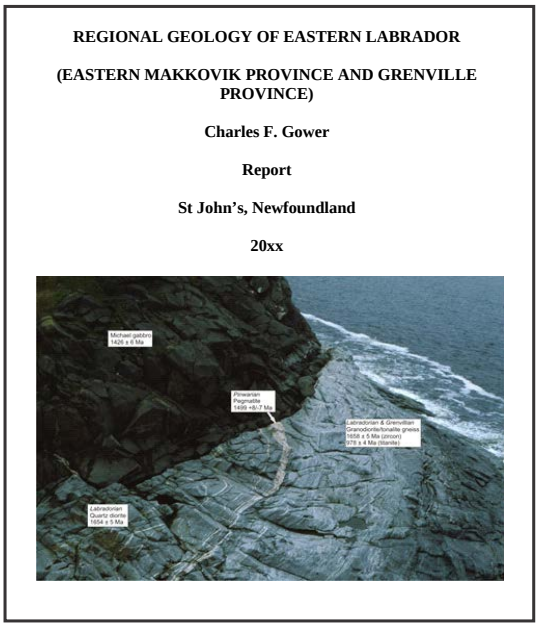
RG-3 Regional Geology in Eastern Labrador

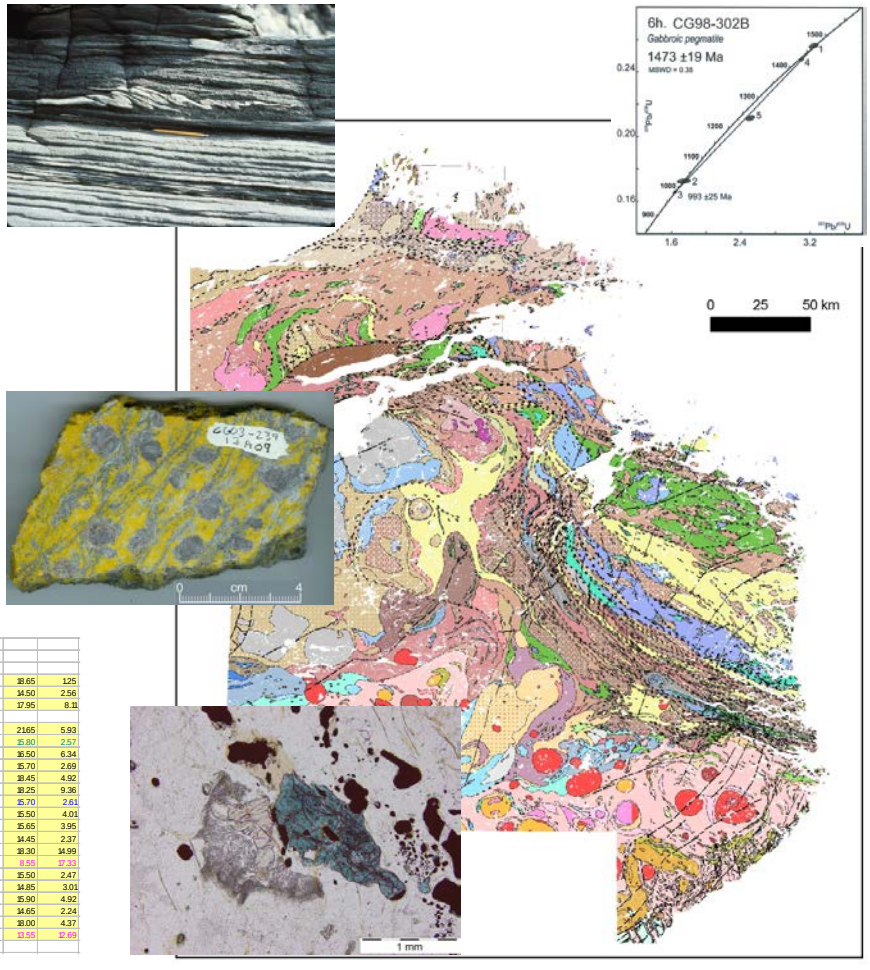
Charles F. Gower

A long-term regional mapping project in eastern Labrador has recently been completed and final materials delivered for publication. The project started in 1979, mapped the eastern parts of the Makkovik-Grenville provinces in southern Labrador, both of which are underlain by mostly igneous plutonic rocks and medium- to high-grade metamorphic rocks. The region mapped covers an area of roughly 80 000 km², which is equivalent to over 70% of insular Newfoundland or 0.8% of Canada. Twenty-five maps, at 1:100 000-scale, covering the whole area have already been published and are now complemented by a comprehensive digital database and a detailed written report. The digital database includes field geological and structural information (28 735 data stations), sample listing, petrographic data, whole-rock and mineral geochemical data, mineral-occurrence information, paleomagnetic and isotopic data; taken from both project-mapping and historical sources. All this information is embedded in ArcGIS product that includes original post-season map and traversing information, government and industry aeromagnetic data, digital elevation model data, and a regional structural interpretation. Also included are hyperlinks to imagery from field photographs, stained slabs (*ca.* 16 000 samples), photomicrographs and geochronology regression figures. The digital database and GIS map product are complemented by a manuscript-page report plus summary tables, figures (146), plates, photomicrographs, and unit-by-unit composite stained-slab imagery.

Outcomes

- Gower, C.F. 2010: Bedrock geological maps for the Grenville Province and adjacent Makkovik Province in eastern Labrador. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Maps 2010-01 to 2010-25, 1:100 000 scale.





640	640460		SY-2	Control						
641	640460		MRG-1	Control						
642	640460		GD-1	Control						
643	640461	P3Asp	CG81-348B		Curlew Harbour pelitic gneiss	66.30	0.14		18.65	1.25
644	640462	P3Asp	CG81-355		Curlew Harbour pelitic gneiss	69.90	0.42		14.50	2.56
645	640463	P3Bdr	CG81-360		Diorite gneiss, Table Bay	56.20	0.86		17.95	8.11
646	640463A		MRG-1	Control						
647	640464	P3Bln	CG81-367		Leucogabbro, Table Bay	53.70	0.71		21.65	5.93
648	640465	P3Cln	CG81-370	Duplicated	Monzonite, Table Bay	68.10	0.40		15.80	2.57
649	640466	P3Bmz	CG81-371		Monzogabbro, Table Bay	60.20	0.72		16.50	6.34
650	640467	P3Bmz	CG81-380		Monzonite, Table Bay	66.70	0.40		15.70	2.69
651	640468	P3Bmz	CG81-384		Monzonite, Table Bay	60.50	0.56		18.45	4.92
652	640469	Nd	CG81-393		Long Range dyke	48.30	1.95		18.25	9.36
653	640470	P3ln	CG81-370	Duplicate	Monzonite, Table Bay	67.40	0.34		15.70	2.61
654	640471	P3Bmq	CG81-399		Monzonite, Table Bay	65.00	0.53		15.50	4.01
655	640472	P3Bmq	CG81-404		Monzodiorite, Table Bay	64.80	0.36		15.65	3.95
656	640473	P3Cqp	CG81-425		Cartwright pluton granodiorite	69.50	0.45		14.45	2.37
657	640474	P3Cnq	CG81-426		Table Bay (south) gabbro norite	46.00	2.46		18.30	14.99
658	640474A		MRG-1	Control		39.10	3.84		8.55	17.33
659	640475	P3Cqp	CG81-429B		Cartwright pluton alkali-feldspar granite (1545 Ma)	69.70	0.29		15.50	2.47
660	640476	P3Cqp	CG81-435		Cartwright pluton granite	68.20	0.43		14.85	3.01
661	640477	P3Bmq/d	CG81-443		Cartwright pluton monzodiorite	63.60	0.55		15.90	4.92
662	640478	P3Bgd	CG81-445		Granite, Groswater Bay terrane	70.30	0.33		14.65	2.24
663	640479	P3Bgp	CG81-450		K-feldspar megacrystic granitoid, Groswater Bay terrane	62.80	0.55		18.00	4.37
664	640480		BCR-1	Control		53.60	2.26		13.55	12.69
665	640480		GD-1	Control						

RG-4 Geological Heritage and Geological Tourism in Newfoundland and Labrador

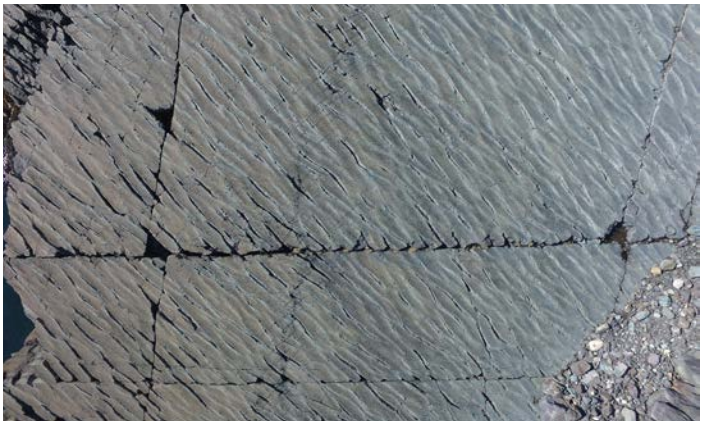
Alana Hinchey

The geotourism projects undertaken by the Geological Survey are collaborative programs with the Department of Tourism, Culture Industry and Innovation, as well as with local partners and stakeholders. These include the Aspiring Discovery Geopark on the Bonavista Peninsula and the Aspiring Cabox Geopark in the Bay of Islands region.

In collaboration with the Aspiring Cabox Geopark, the Geological Survey is an active participant in the Northern Peripheries and Arctic Region Project, entitled – "Drifting Apart". This project is in year 2 of 3, and supports the development of new and Aspiring Global Geoparks, the promotion of innovative products and services for social and economic prosperity, and to continue to build a strong network of geoheritage destinations. As part of this project, the Survey produced drone imagery, panoramas and 3D models of geological features on the west coast.

Also, over the last several years, the Survey supported the bid for Mistaken Point to be named an United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site. Fossils found at the site are the oldest, architecturally complex, multicellular life forms found on Earth, and represent the remains of soft-bodied creatures that lived 560 to 580 million years ago (during the geological Ediacaran Period). In June, 2016, the coastline of Mistaken Point Ecological Reserve was inscribed as a World Heritage Site by UNESCO. This became the first provincially managed World Heritage Site.

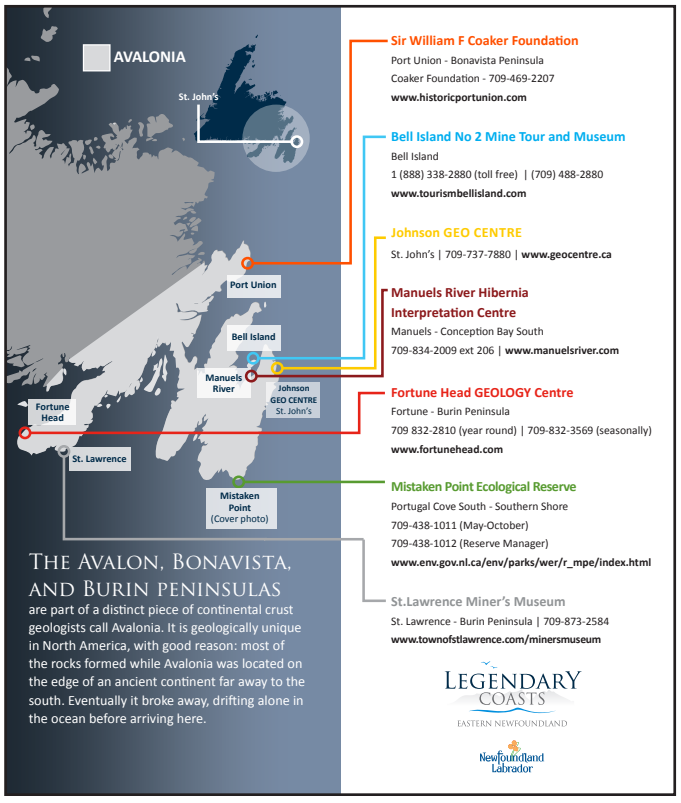
In 2016, the Eastern NL Geological Network was developed and is a partnership between Bell Island Community Museum and #2 Mine, Discovery Aspiring GEO Park, Fortune Head GEOLOGY Centre, Johnson GEOCENTRE, Manuels River Hibernia Interpretation Centre, Mistaken Point Ecological Reserve, and the St. Lawrence Miner's Museum and government partners. The network's purpose is to undertake cooperative efforts to ensure the sustainable development and promotion of



the geological story for eastern Newfoundland. A brochure connecting the sites entitled "Avalonia's Geological Mysteries" has been published and distributed throughout the province.

Outcome

- A new app, highlighting the geological heritage of the Bonavista Peninsula.



RG-5 The Forteau Formation, Southern Labrador, the Great Northern Peninsula and Gros Morne National Park, Western Newfoundland

*Ian Knight, W. Douglas Boyce, *Christian Skovsted and **Uwe Balthasar*

The Forteau Formation is a late Early Cambrian succession of limestone, shale and siltstone deposited on a warm, shallow-marine shelf that formed along the ancient North American (Laurentian) continent about 512 million years ago. It is famous, internationally, for its archeocyathid reefs and for a diverse assemblage of other fossils. A shallow-shelf succession in Labrador and western Great Northern Peninsula can be shown to deepen to the southeast and south into a deeper water outer-shelf succession from Canada Bay to Gros Morne, to Stephenville.

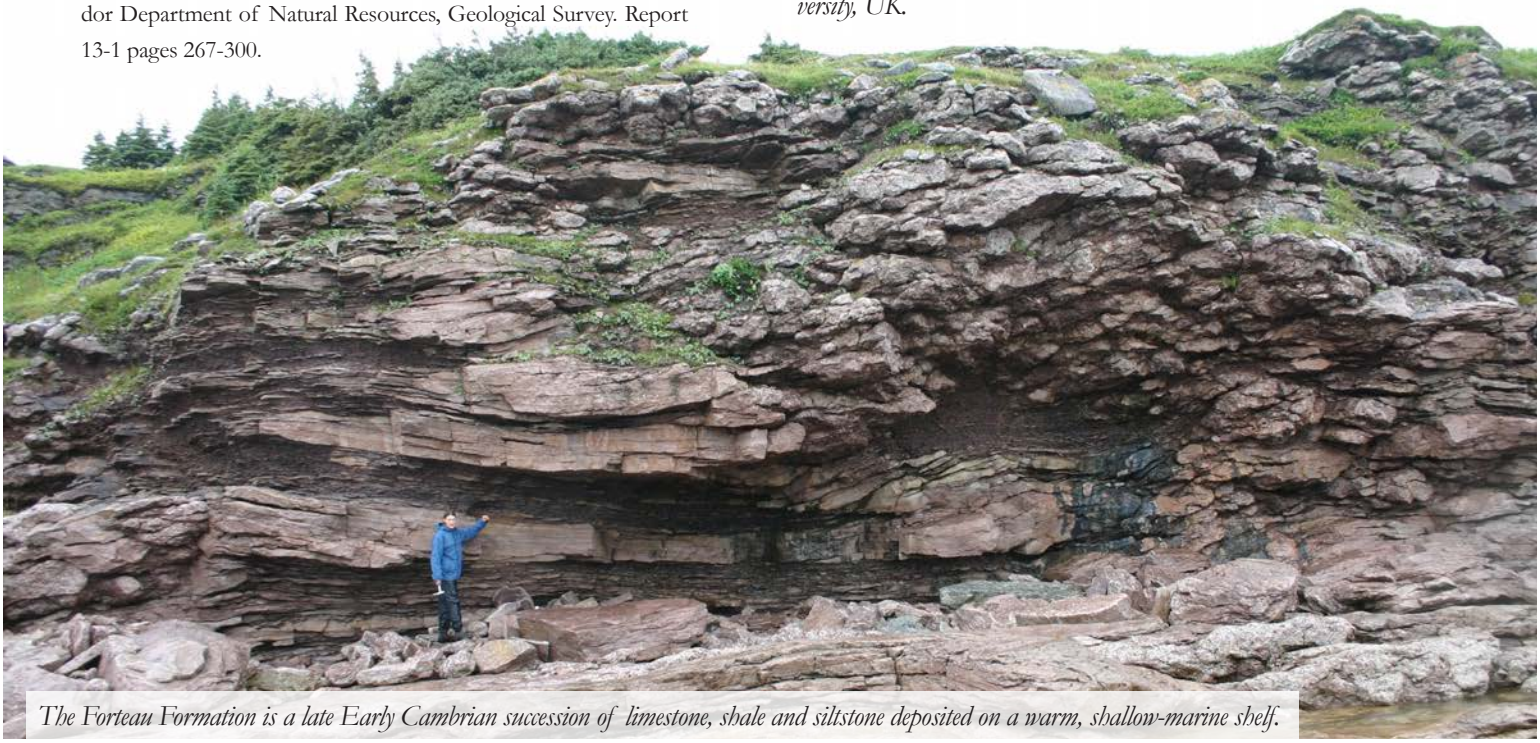
Outcomes

- Identify, describe and define geographic extent of rock types that make up the formation.
- Understand the type, evolution, depositional systems and extent of the Forteau shelf.
- Identify the trilobite and small shelly faunas in order to refine the dating and correlation of the succession with similar sequences elsewhere in North America, Scotland and Greenland.

- Knight, I, Boyce, W.D, Skovsted C and Balthasar, U 2017: The Forteau Formation, southern Labrador and western Great Northern Peninsula, western Newfoundland: lithostratigraphy, trilobite and depositional setting. *In press.*
- Knight, I., and Boyce, W.D., 2015: Geological Guide to the Bird Cove region, Great Northern Peninsula. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Open File NFLD/3239, 50 pages.
- Knight, I., 2013: The Forteau Formation, Labrador Group, in Gros Morne National Park: A preliminary reassessment of its stratigraphy and lithofacies. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey. Report 13-1 pages 267-300.

** Senior Curator, Naturhistoriska Riksmuseet Stockholm, Sweden.*

*** School of Geography, Earth and Environmental Sciences, Plymouth University, UK.*



The Forteau Formation is a late Early Cambrian succession of limestone, shale and siltstone deposited on a warm, shallow-marine shelf.

RG-6 Bedrock Mapping on the Bonavista Peninsula, Northeastern Newfoundland

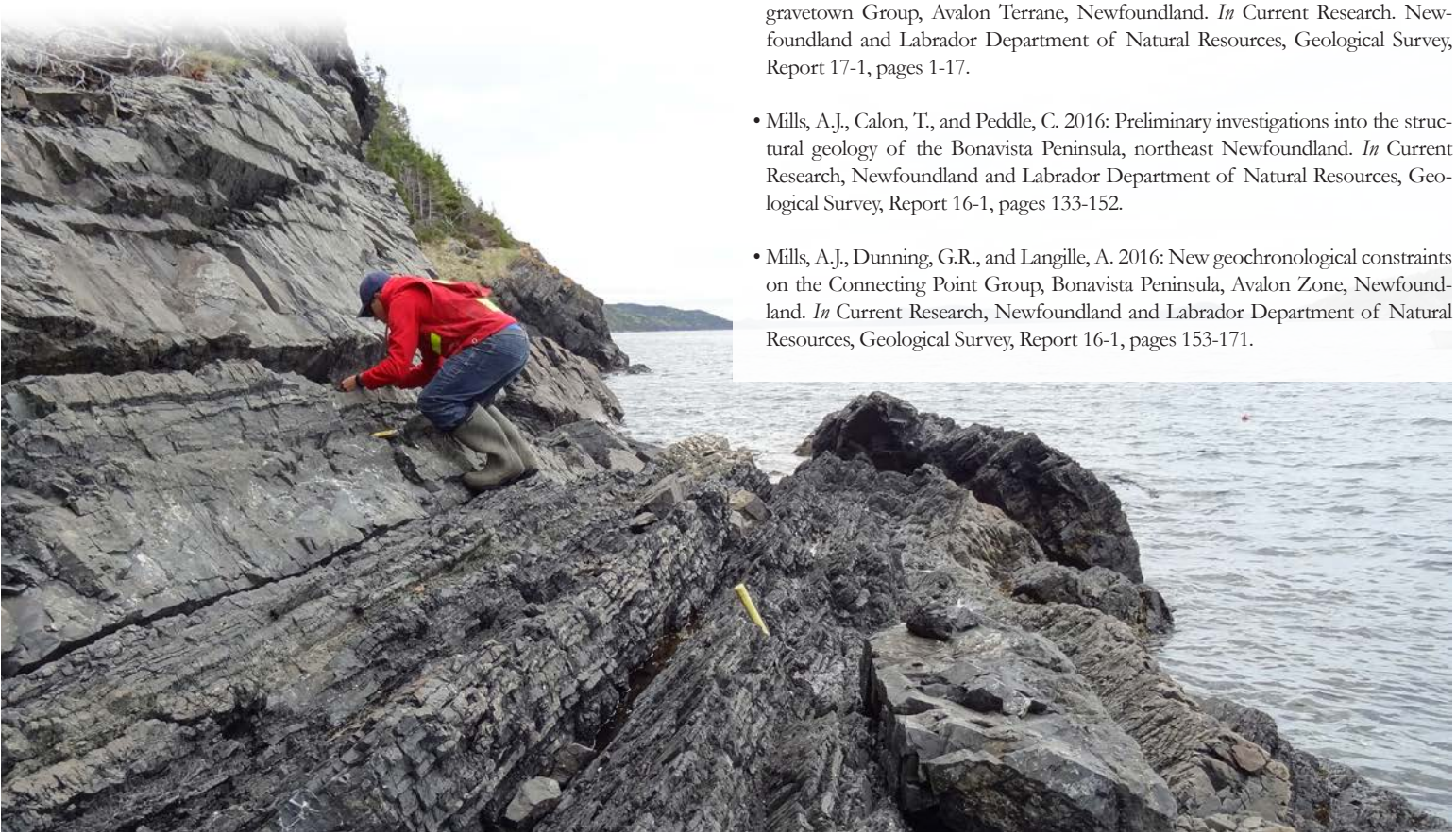
Andrea J. Mills

In 2013, the Geological Survey began a renewed bedrock mapping project on the Bonavista Peninsula, building upon previous work conducted between 2009 and 2011, to improve understanding of the bedrock geology and mineral potential of the region. In the late 1990s, copper mineralization was discovered in reduced redbeds on the northwest part of the peninsula and in fine-grained, grey sandstone in the southwest part near the community of Trinity. In addition, copper, gold, and barite occurrences are known to occur in the volcanic-dominated Bull Arm Formation at the isthmus that connects the Avalon Peninsula to the rest of the Island. However, similar mineralization has not yet been identified in the 2-km-thick, >25-km-long, north-trending volcanic belt mapped as Bull Arm Formation on the west side of the Bonavista Peninsula. The goal of this project is to produce bedrock geology maps covering the entire peninsula, and to understand the complex stratigraphic, magmatic and structural relationships of the rocks.

Outcomes

- Recognition of volcanic suites of differing ages and composition within the Bull Arm Formation, as well as differing sedimentary 'cover sequences' overlying the volcanic suites.
- Acquisition of three new age constraints on volcanic rocks previously assigned to the Bull Arm Formation.
- Development of a geological model to convey new insight into the timing of events affecting rocks in the area.

- Mills, A.J., Dunning, G.R., Murphy, M., and Langille, A. 2017: New geochronological constraints on the timing of magmatism for the Bull Arm Formation, Musgravetown Group, Avalon Terrane, Newfoundland. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 17-1, pages 1-17.
- Mills, A.J., Calon, T., and Peddle, C. 2016: Preliminary investigations into the structural geology of the Bonavista Peninsula, northeast Newfoundland. *In* Current Research, Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 16-1, pages 133-152.
- Mills, A.J., Dunning, G.R., and Langille, A. 2016: New geochronological constraints on the Connecting Point Group, Bonavista Peninsula, Avalon Zone, Newfoundland. *In* Current Research, Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 16-1, pages 153-171.



RG-7 Mafic Intrusive Rocks from the Bonavista Peninsula, Avalon Terrane, Northeastern Newfoundland

Andrea J. Mills

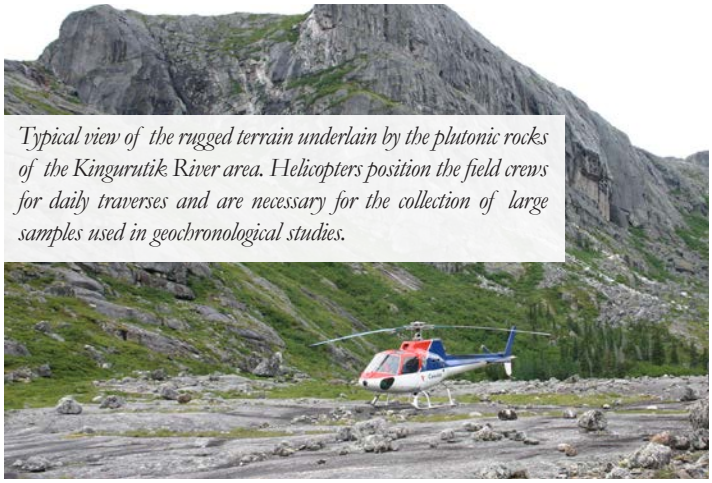
New bedrock mapping and sampling of volcanic and intrusive rocks from the Bonavista Peninsula have led to identification of a number of distinct magmatic suites reflecting differing processes of formation in distinctive geological settings. Modern geochemical analytical methods and improved detection limits have led to a more refined understanding of the origin of igneous rocks in known tectonic settings that may be applied to ancient igneous rocks to elucidate the geological history of an area. In 2013, the Geological Survey began investigations on volcanic rocks formerly assigned to the Bull Arm Formation and has extended the studies to include tabular intrusive bodies, known as dykes, that crosscut the sedimentary rocks, which cover most of the Bonavista Peninsula.

Outcomes

- Improved documentation of volcanic and intrusive rocks that occur on the Bonavista Peninsula
- Acquisition of new data (*e.g.*, lithogeochemistry) to complement exploration models
- Recognition of four distinct volcanic suites formerly assigned to the Bull Arm Formation and five distinct intrusive suites across the peninsula.
- Mills, A.J. and Sandeman, H.A.I. 2015: Preliminary lithogeochemistry for mafic volcanic rocks from the Bonavista Peninsula, northeastern Newfoundland. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 15-1, pages 173-189.

RG-8 U-Pb Geochronology of the Western Part of the Nain Plutonic Suite, Kingurutik River Area, Labrador

*Bruce Ryan, *Jim Connelly and **Don James*



Typical view of the rugged terrain underlain by the plutonic rocks of the Kingurutik River area. Helicopters position the field crews for daily traverses and are necessary for the collection of large samples used in geochronological studies.

Geochronology, the science of determining the ages of rocks, is an essential analytical tool in understanding geological history. Ages are derived from the ratios of specific uranium (U) and lead (Pb) isotopes in zircon, a tiny mineral common in rocks formed from the crystallization of magma in plutonic (subterranean) settings. U-Pb geochronology of zircon in the plutonic rocks surrounding the Voisey's Bay nickel-copper-cobalt sulphide deposit in Labrador, for example, demonstrated that they are 1333 million (1.3 billion) years old.

Geochronology has now been applied to plutonic rocks in the Kingurutik River area, 75 km inland northwest of Nain, Labrador. That area, where the bedrock is comparable to that on the coast at Nain, had been the focus of a 900-square-kilometre, helicopter-supported mapping project in 2004. The rocks of the coastal region around Nain and Voisey's Bay, collectively referred to as the Nain Plutonic Suite, range between 1333 and 1290 million years old, but no ages were available for plutonic rocks inland. Zircons were, therefore, isolated from several rock types near the Kingurutik River and analyzed for isotopic U and Pb. The U-Pb ages range from 1349 to 1337 million years. These results demonstrate that the rocks of the Kingurutik River region are tens of millions of years older than similar ones in the coastal area around Nain and Voisey's Bay.

The geochronology highlights the prolonged span of Earth history, at least 60 million years, covered by the rocks of north-central coastal Labrador. The older Kingurutik River rocks in comparison to those of the Nain and Voisey's Bay areas should not, however, be misinterpreted to indicate that they are less likely than ones along the coast to contain metallic minerals. In fact, similar mineralizing processes may have been active. It is now accepted that the melting of large volumes of more ancient sulphur-rich rocks were critical to the formation of the nickel-copper-cobalt accumulations in the magma. One local occurrence of such older sulphide-mineral-rich rocks near the Kingurutik River, the West Mar-

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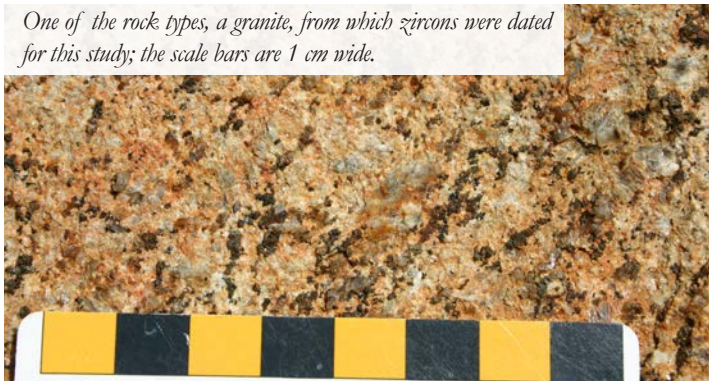
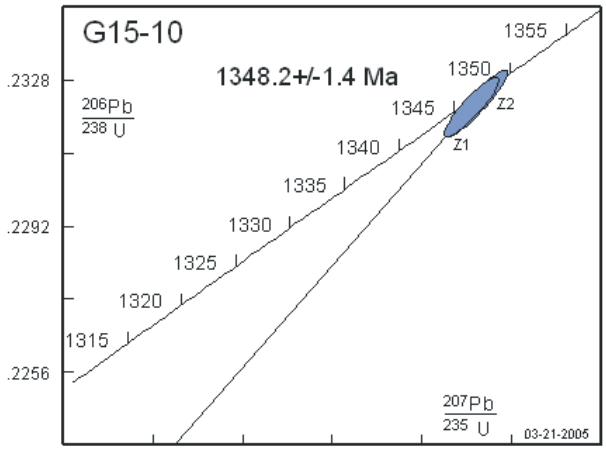
*** Geoscience and Mines Branch, Department of Natural Resources, Halifax, N.S. Canada.*

One of the rock types, a granite, from which zircons were dated for this study; the scale bars are 1 cm wide.



gin property, was the target of economic assessment by several exploration companies between 1998 and 2008. Conceivably, these older rocks could have 'contaminated', and subsequently promoted metal formation in, some of the magmatic rocks of the Kingurutik River area. One of the dated plutonic rocks displays evidence of such magmatic melting of older rocks, so metal-concentrating processes like those responsible for the Voisey's Bay sulphide deposit cannot be entirely discounted for the western area.



A graphic plot of U and Pb isotope data derived from analyses of zircons extracted from granite. The rock is 1348 million years old (1348.2+/-1.4 Ma). The lower picture shows the minute zircon crystals from which the age was obtained; the wire used for scale, is 0.1 mm in diameter.

RG-9 Geology of the Ashuanipi Complex, Western Labrador (NTS Map Sheets 23J/02, 03 and part of 23J/04)

*Tim S. van Nostrand and *Sarah Broughm*

In 2013, the Geological Survey initiated an 1:50 000-scale bedrock mapping project of the northern Ashuanipi Complex, Superior Province in western Labrador. The purpose was to elucidate the igneous and metamorphic evolution of the rocks, and to evaluate the mineral potential of this under-explored region of the province. The 2016 season was the final year of the project and consisted of 8 weeks of helicopter-supported ground traversing/surveying in the McPhadyen River area of western Labrador.

The region is underlain by 3.0 to 2.6-billion-year-old sedimentary and igneous rocks that have been buried to estimated depths of 10 to 20 km during the Archean. The rocks consist of gneisses and associated migmatites (melted rocks), granitoid rock plutons, mafic and ultramafic intrusions and pegmatite. These rocks have been affected by high-temperature partial melting, and two episodes of folding that have resulted in very complex geological relationships. Previous studies have shown that these rocks have the potential to host gold, base-metal and platinum-group-element mineralization, although only cursory follow-up work has been carried out and large areas remain unexplored.

Outcomes

- Further subdivision of the migmatitic rocks and new mapping of mafic-ultramafic intrusions and late-stage granitoid plutons.
- Discovery of several new mineral occurrences hosted in gneisses, gabbro and pyroxenite that may contain anomalous gold, base metals and platinum-group elements.
- Recognition of radioactive mineralization indications (U, Th and rare-earth elements) hosted in granite and alkali-feldspar granite pegmatites. These rocks represent an untested mineral exploration target in the region.

- van Nostrand, T.S. and Broughm, S. 2017: Geology of the Ashuanipi Complex, western Labrador (NTS map sheets 23J/02, 03 and part of 23J/04) *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 17-1, pages 61-86.
- van Nostrand, T.S., Westhues, A. and Broughm, S. 2016: Geology of the northeastern Ashuanipi Complex, western Labrador (parts of NTS 23J/05, 06, 07 and 11) *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 16-1, pages 173-196.
- van Nostrand, T.S. and Bradford, W. 2014: Geology of the northeastern Ashuanipi Complex, western Labrador (parts of NTS 1:50 000-scale map areas 23J/06, 07, 10, 11, 14 and 23O/03) *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 14-1, pages 189-216.

** Department of Earth Sciences, Memorial University of Newfoundland.*

RG-10 Geology of the St. Alban's Map Area (NTS 1M/13, Dunnage and Gander Zones)

Anne Westhues

A new bedrock mapping project was started in 2016 in the St. Alban's map area around Bay d'Espoir on the south coast of Newfoundland. The results are used, together with new detailed airborne geophysical surveys, to improve the understanding of the geology and mineral potential of the area. The Bay d'Espoir area contains several gold, arsenic, antimony and lead showings, and underexplored rocks that have similar mineral potential extend farther to the northeast into central Newfoundland.

The objective of this study is to document the bedrock geology and related mineralization in the St. Alban's map area, part of the Newfoundland Appalachians. Field work during the summer of 2016 helped refine the geological contacts of the different rock units and to assess their mineral potential. Rock samples for geochemical analyses, and samples for geochronology (age determination) were collected as part of this project. On the completion of this study the results will be presented in a detailed GIS-integrated map along with associated databases, and will be a valuable asset for mineral exploration and land-use planning.

Detailed bedrock mapping further improved our understanding of the geology of the area and, will help to explore new targets for their mineral potential. The Ordovician Baie d'Espoir Group of the Dunnage Zone is the dominant unit within the map area and is considered to have been formed along the eastern margin of the ancient Iapetus Ocean. These rocks have been transposed and lifted on to rocks of the Gander Zone during Silurian and Devonian mountain-building processes, which now makes them accessible. Plutonic rocks, such as the Gaultois Granite and the North Bay Granite Suite, intruded the area during those tectonically (mountain building) active times. The heat provided by these intrusions is potentially responsible for the circulation of metal-bearing fluids through the tectonic structures – a better understanding of these processes can guide future exploration for mineral deposits.

Carbonate-quartz vein surrounded by iron-rich alteration in shale/shales (?) at Pardy Head, close to Head of Bay d'Espoir.

Outcomes

- Westhues, A., 2017: Open File 001M/13/0872; geochemical results from known and previously unknown mineralized zones having elevated gold (Au), silver (Ag), antimony (Sb), and arsenic (As) values, and locally elevated base metal (Cu, Pb, Zn) contents.

- Westhues, A., 2017: Updated geology of the St. Alban's map area (NTS 1M/13), Dunnage and Gander zones. *In* Current Research, Newfoundland and Labrador Deptarment of Natural Resources, Report 2017-1, pages 87-103.

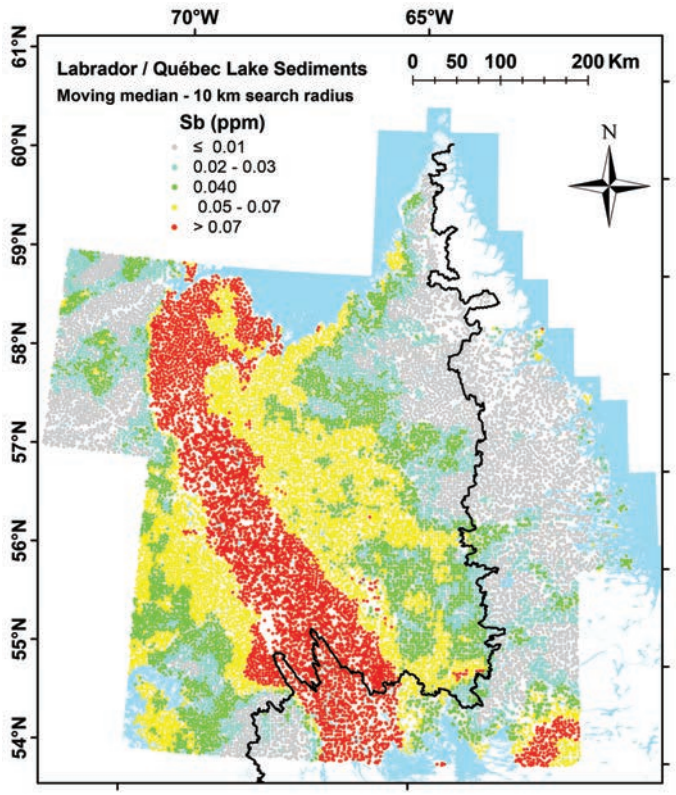
GG-1 Merging Lake-Sediment Data from Québec and Labrador

Stephen Amor

Combination of lake-sediment geochemical results from Labrador and northeastern Québec is complicated because of the differing analytical protocols applied in the two regions. Whereas the Québec samples were digested using *aqua regia* (nitric and hydrochloric acids) prior to analysis, certain elements in the Labrador samples had previously only been analyzed either after a near-total digestion (hydrochloric/hydrofluoric/perchloric acids) or by the total-element method of neutron activation. Depending on the reagent used, differing portions of many elements go into solution (thereby becoming detectable by the analytical equipment) because of the varying acid resistance of their host minerals. To create a more concordant regional dataset; 5510 Labrador samples were re-analyzed for 53 elements after *aqua regia* digestion.

Rocks of the Labrador Trough (New Québec Orogen) have given rise to the most extensive and distinctive patterns, particularly of chalcophile (sulphur-associated) and siderophile (iron-associated) elements. For some (*e.g.,* copper and lead), the most strongly elevated values extend only 300 km from 54° 45' N to about 57° 30' N, whereas the highest values of arsenic and antimony define a curvilinear feature that extends over the trough's entire 600-km strike length. The well-documented glacial-dispersion train associated with the Strange Lake/Lac Brisson rare-earth (*e.g.*; lanthanum) is also defined by elements such as tin, and appears to extend at least 25 km westwards into Québec. The distribution of sulphur closely follows that of loss-on-ignition (LOI) in Labrador, where values falls sharply, north of approximate latitude 57°N.

This work, which was partially funded by the Geological Survey of Canada's Geo-mapping for Energy and Minerals (GEM-2) program, has been successful in eliminating the discontinuity at the provincial border for most elements, and in creating geochemical maps covering an area of 300 000 km².



Distribution of antimony in lake sediments of Labrador and northeastern Québec. The linear zone of high values extending from the Smallwood Reservoir to Ungava Bay corresponds to the iron-ore producing Labrador Trough, which has potential for other metals.

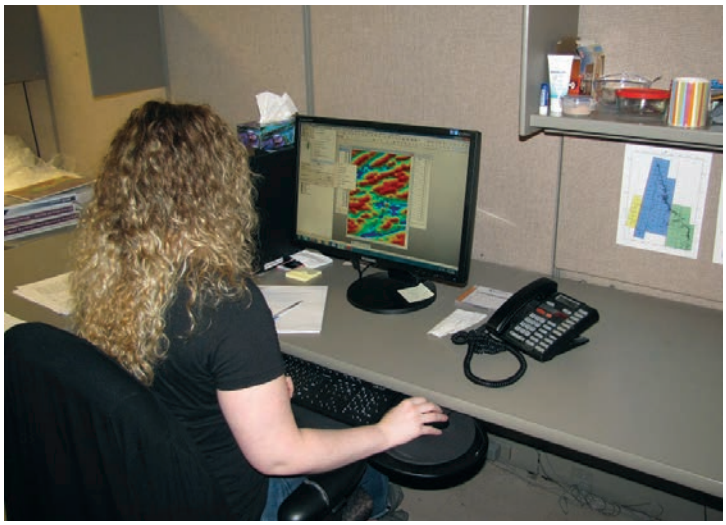
Outcome

• Amor, S.D., McCurdy, M., Garrett, R.G., Corrigan, D. and Solgadi, F. 2016: Amalgamated Lake-Sediment Data from Quebec and Labrador. Explore, 173, pages 1-17 www.appliedgeochemists.org/images/Explore/Explore_Number173_Dec2016.pdf

Lake sediments and waters are most efficiently collected for analysis with helicopter support. A tube sampler has just been retrieved from the lake bottom and its contents are being emptied into a sample packet.

GG-2 Optimal Use of Geophysical Survey Results

Gerry Kilfoil and Robyn Constantine



Geophysical surveys have been conducted both by government programs and as part of mineral exploration activities, since the 1950s. Regional geophysical surveys are most efficiently carried out from aircraft. Based on those results, areas deemed prospective for mineral exploration are often followed up with detailed ground surveys. More detailed 3D models of geological structures can be created using geophysical data acquired from boreholes, usually after a potential mineral resource has been identified and drilled. As a result of this work, a very large archive of geophysical data from within the province has already been acquired at various scales and compiled, most of which exists both as paper maps within our archive of assessment reports, and as captured digital recordings. This information can be combined in various ways with other geoscience data to improve our understanding of bedrock geology and economic mineral resources. Geophysical data are especially relied upon to interpret subsurface geology and structure in areas where bedrock is poorly exposed, being covered by extensive soil and glacial till deposits.

Outcomes

- Acquire new geophysical data where gaps in existing data coverage exist.
- Provide assurance that all new geophysical information is archived accurately and in a consistent format, to facilitate future retrieval and maximize access.
- Reformat and reprocess historical data to current standards.
- Generate maps, images and interpretation products from the geophysical data, that optimize its use in assisting bedrock mapping efforts and mineral exploration activities.
- Maintain an online digital archive of geophysical data products, and maximize its availability to the public through the Geoscience Atlas.

GG-3 Surficial Mapping and Drift Prospecting in the Cormack (NTS 12H/06) and Silver Mountain (NTS 12H/11) Map Sheets

Sarah Hashmi

Melting glacier depositing till on the ground.

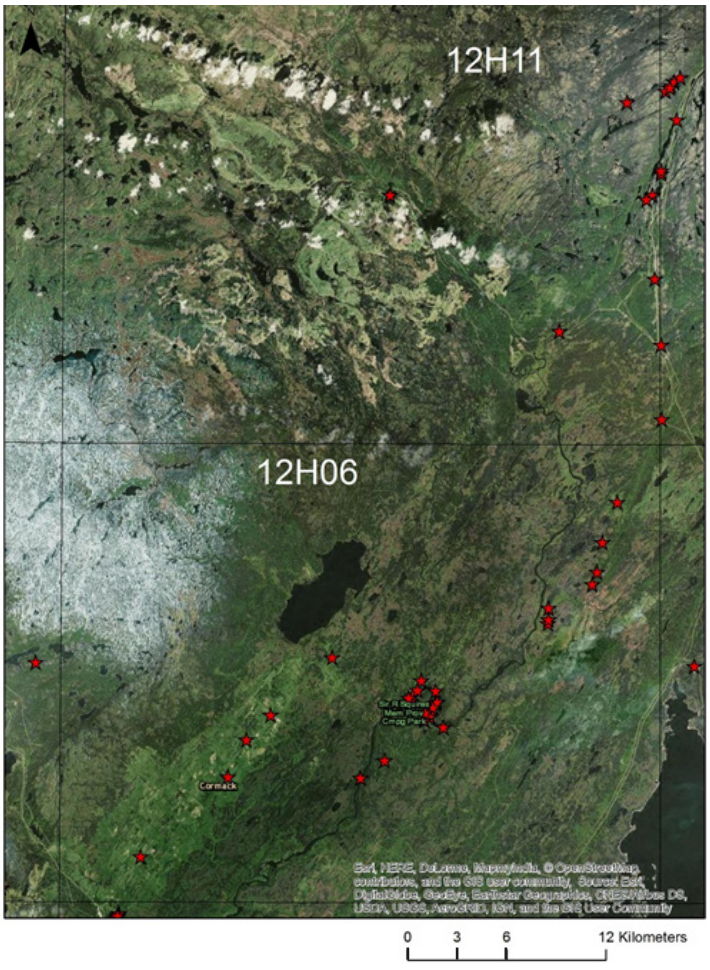
Drift prospecting is the process of tracing mineralization back to its original bedrock source in glaciated terrain. During the last glaciation (approx. 20,000 years ago), glaciers covered almost all of Canada, eroding, modifying, transporting and depositing sediments (commonly referred to as till) down-ice in the direction of flow. If a glacier eroded mineralized bedrock, the mineral signature will be present in till, and the glacier's direction of flow will be preserved in the sculpted bedrock (as striations or grooves). Drift prospecting has been successfully used in the past to discover world-class diamond and gold deposits in Canada.

Surficial mapping and drift prospecting studies will be carried out this summer in the Cormack and Silver Mountain map areas, where there have been multiple reported occurrences of metals such as gold, copper, uranium and iron as well as oil shale. Surficial geology maps and ice-flow markers were mapped in the 2000s, however, the mapping needs to be updated, utilizing newer mapping techniques and spatial and 3D imagery software. The two main objectives of this study are: i) map the surficial geology of the study area, where field work will include documentation of surficial sediment cover. Mapping of surficial sediments will help determine till sampling sites and delineate regions where other surficial resources such as sand and gravel (for aggregate) may be present, as well as identify potential hazardous regions with frequent natural hazard activity (hazard analysis and risk assessment studies). Ice-flow indicators will be measured to estimate the direction of glacial transport, and. ii) a regional till-sampling survey will also be completed in order to identify any potential mineralization targets in the study area as well as follow up on previously reported mineral occurrences and identify their signature in till.

Samples will be sent for geochemical analysis at the Geological Survey's laboratory in St. John's to determine the geochemistry. Select samples showing highly anomalous levels of key elements of interest may also be sent for indicator mineral recovery, which may lead to identifying regions of interest for further exploration.

Outcomes

- Surficial geology map of Cormack Township (NTS 12H06) (Winter/Spring 2018)
- Surficial geology map of Hampden Township (NTS 12H10) (Winter/Spring 2018)
- Surficial mapping and sampling in the Cormack and Hampden townships. Current Research 2018-1
- Till geochemistry and indicator mineral signature in the Cormack and Hampden townships: recommendations for mineral exploration. (Open file Report (Winter 2018)



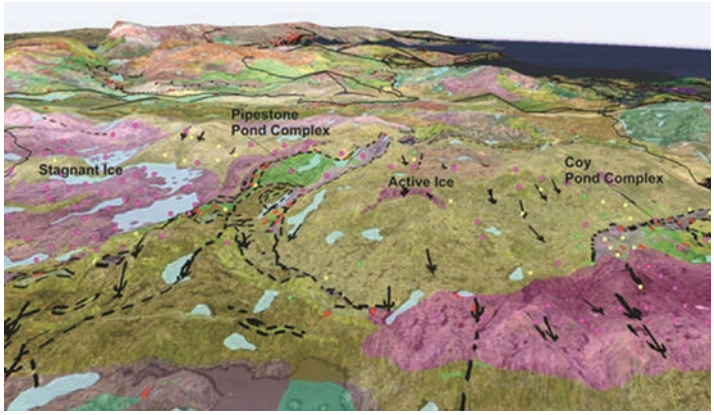
Orthoimagery of the study area. Red stars indicate locations of reported mineral occurrences.

TS- 1 Till-Geochemistry Sampling and Quaternary Mapping, South-Central Newfoundland

Heather Campbell, Jennifer Organ and David Taylor

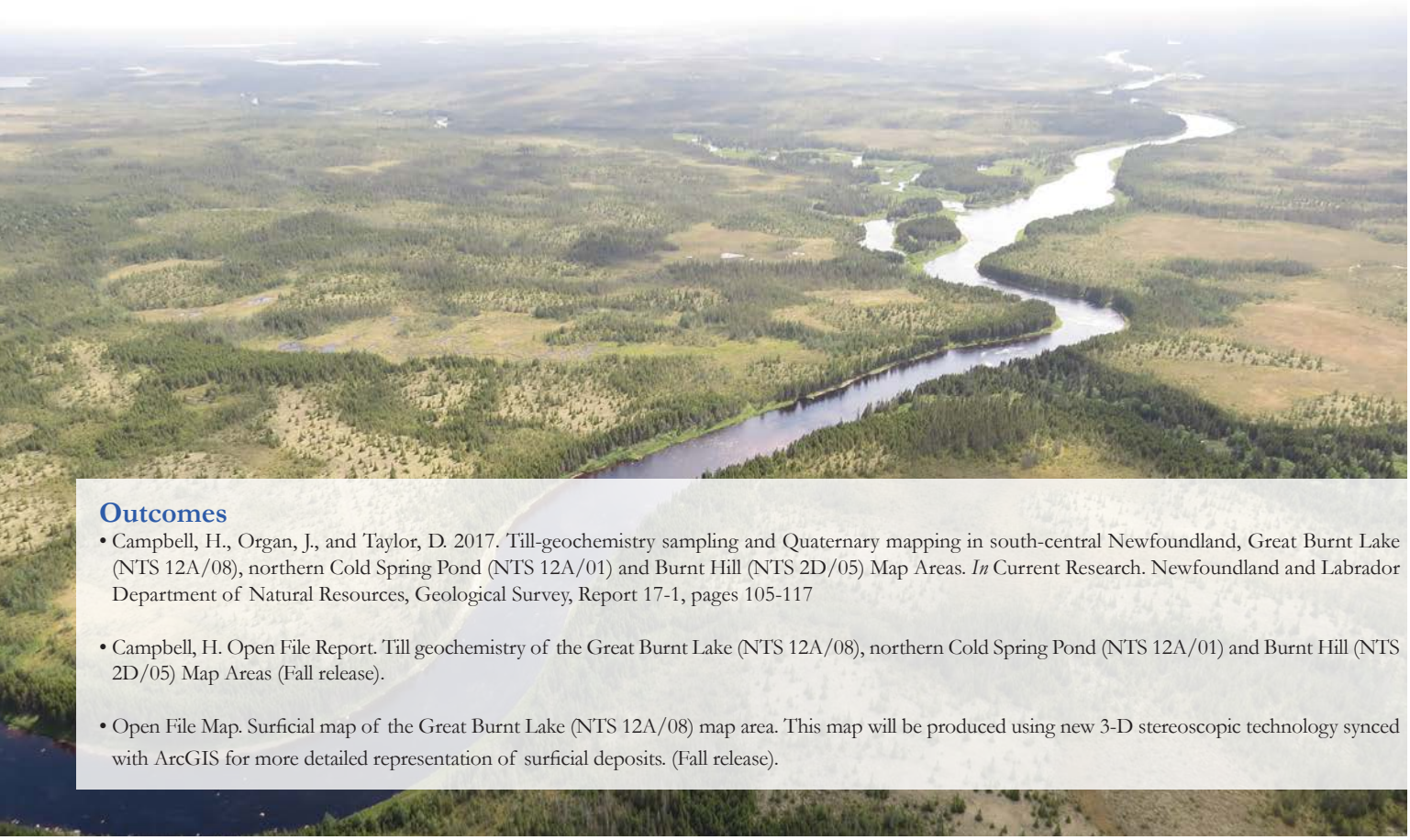
Systematic glacial-sediment sampling surveys were conducted over the Great Burnt Lake, Burnt Hill and northern Cold Spring Pond map areas, south-central Newfoundland. Past exploration efforts have been confined to the Pipestone Pond and Coy Pond complexes; two mineralized volcanic and plutonic rock belts that host a variety of base- and precious-metal occurrences. The samples of glacial sediment (till), derived from bedrock, were sampled on a 4km^2 grid and analyzed for a broad suite of elements including gold, copper and nickel. This was done to assess and delineate the dispersion of minerals, and to identify new targets for future exploration.

The study examined 552 samples collected from hand-dug, glacial sediment test pits. Ice-flow indicators (striation marks) indicate that the ice flowed south and southeast in the Burnt Hill area which is located directly south of an ice divide. Differences were observed, in the both the glacial environment and sediment composition, east and west of the Pipestone Pond complex. The environment to the west formed under a stagnating ice sheet, where sediment erosion from melting ice occurred during and after deglaciation. The environment to the east formed in a more active (erosional) glacial environment. Observations of coarse material in test pits indicate that material has been transported ~2 to 6 km south of its source. The presence of recognizable volcanic material from the Coy Pond Ophiolite Complex, up-ice of mapped bedrock units, suggests the complex may extend farther west, under glacial cover. Further investigations into this are warranted given the mineralization hosted by the rocks in this area.



Oblique view of the study area (elevation exaggerated) showing the mineralized complexes (with individual occurrences of mineralization in red). Green dots indicate clasts derived from the volcanic units which host mineralization. Yellow and pink dots indicate clasts derived from granites and metasediments.

The samples are being analyzed at the Geological Survey of Newfoundland and Labrador labratory, and an external lab, for 48 elements. The results will be released in an upcoming Open File report. A map detailing glacial sediments and landforms of the Great Burnt Lake map area will be released later this year.



Outcomes

- Campbell, H., Organ, J., and Taylor, D. 2017. Till-geochemistry sampling and Quaternary mapping in south-central Newfoundland, Great Burnt Lake (NTS 12A/08), northern Cold Spring Pond (NTS 12A/01) and Burnt Hill (NTS 2D/05) Map Areas. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 17-1, pages 105-117

- Campbell, H. Open File Report. Till geochemistry of the Great Burnt Lake (NTS 12A/08), northern Cold Spring Pond (NTS 12A/01) and Burnt Hill (NTS 2D/05) Map Areas (Fall release).

- Open File Map. Surficial map of the Great Burnt Lake (NTS 12A/08) map area. This map will be produced using new 3-D stereoscopic technology synced with ArcGIS for more detailed representation of surficial deposits. (Fall release).

TS- 2 Quaternary Mapping and Till Geochemistry, Woods Lake, Western Labrador (NTS 23I/03, 04, 05, 06, 11 and 12)

*Heather Campbell, *Roger Paulen and **Jessey Rice*

This study examines the ice-flow movements, and the glacial sediment transport from bedrock units that host base-metal and gold mineralization in the Woods Lake map area. The results will determine the extent of dispersion from mineralization, and possibly identify targets not yet discovered through traditional prospecting and exploration methods. Ice-flow reconstructions and sediment transport studies assist in exploration efforts.

Sediments, known as 'till', derived by glacial erosion of bedrock may contain minerals of economic value. Ice-flow movements are reconstructed using erosional indicators; such as i) striae (grooves carved into the rocks by ice movement), ii) orientations of bedrock landforms, and iii) patterns of dispersed mineralization in till. The ice-flow reconstructions trace the glacial sediment transport trajectory back to the mineralized source. This facilitates exploration efforts where bedrock exposure is scarce and sources of mineral occurrences may be buried.

In this study, 54 till samples were collected for geochemical analysis, from hand-dug pits having a sample spacing of 10-12 line-km, and narrowed down to 5-8 line-km in areas of known mineral occurrences. Bedrock material observed in the coarse fraction is thought to be derived from occurrences to the north and northwest of the survey area. Striation measurements indicate older northeast ice flow, and younger south to southeast ice flow, and large-scale landforms are oriented south and southeast.

Samples were analyzed for 48 elements at the Geological Survey's Laboratory in St. John's. Additional physical, chemical and mineralogical parameters will be measured at the Geological Survey of Canada Laboratory. The results will be released as an Open File report, and in subsequent reports jointly with the Geological Survey of Canada. A map detailing glacial sediments and landforms of the southwestern Woods Lake map area will be released later this year.

** Geological Survey of Canada, Ottawa, Canada*
*** Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, ON.*

Erosional indicators (striae) in rock units north of the survey area. These indicators help reconstruct ice-flow histories. The smaller striae, indicated by the blue pen crosscut larger erosional features indicated by the compass. The depth and extent of the indicators can help define the most erosive glacial episode and thus help determine the dominant glacial-sediment transport direction.

Geologist Jessey Rice examining glacial erosion marks in conglomerate bedrock north of the survey area.

Outcomes

• Campbell, H., Paulen P., and Rice, J. 2017. Quaternary mapping and till geochemistry, Woods Lake, western Labrador (NTS 23I/03, 04, 05, 06, 23I/11 and 12). *In* Current Research. Newfoundland and Labrador. Department of Natural Resources, Geological Survey, Report 17-1, pages 119-134.

• Open File Report: Till Geochemistry of the Woods Lake, Western Labrador (NTS 23I/03, 04, 05, 06, 23I/11 and 12) map areas.

• Report presenting and summarizing geochemical results from the survey, with recommendations for exploration.

• Surficial map of the Woods Lake, western Labrador (NTS 23I/03, 04, 05, 06, 11 and 12) map area.

TS-3 Coastal Monitoring Program

Melanie Irvine

Coastal areas are susceptible to hazards due to climate-driven changes, *e.g.,* sea-level changes, increased storm frequencies and severities, sea-ice decrease. Assessments of coastal change over time will help predict coastal response to climate. Standards for data collection are being established and erosional rates in Newfoundland and Labrador are being put into context relative to the rest of Canada. Town planners, policy makers, and other stakeholders can utilize information gathered to prioritize mitigation and adaptation efforts and guide planning. Coastal regions are dynamic environments that present challenges for municipal and land-use planning, safety and infrastructure. Coastal erosion, landslides and flooding affect communities along the coast and subsequent damage to roads, trails, cabins, wharfs, breakwaters, houses and other infrastructure can present significant safety issues, and costly repairs. To address these issues, the Geological Survey is conducting a long-term, province-wide coastal monitoring initiative that provides information on coastal change and associated hazards to communities and stakeholders.

The program's objectives are: quantifying rates of erosion and accretion, determining factors that affect rates of coastal change (*e.g.,* soil types, beach profiles, tides and ocean currents, weather patterns), assessing coastal responses to climate-driven changes (*e.g.,* sea-level changes) and identifying areas at greatest risk from coastal hazards. This program is unique in the province, and uses modern survey techniques and unmanned aerial vehicles (*i.e.* drones) to conduct repeated surveys of coastal areas. High-resolution imagery, digital elevation and 3D models document environmental processes and accurately quantify coastal erosion. Repeated surveys show that interrelated factors such as rock type, cliff and beach composition, site morphology, ocean conditions, climate and anthropogenic change contribute to coastal erosion.

This three-dimensional model of Parsons Pond shows how surface water is creating gullies on the cliff face, resulting in accelerated erosion at a rate of 73 cm/year.

Coastal cliff at Point Verde, 2005. The cliff is eroding at 40 cm/year; wind and water have eroded the sediment under this cement structure which has now fallen to the bottom of the cliff. Quantifying rates of erosion is crucial to determine building setback values to prevent the above loss, as construction impinges on coastal environments.

Outcomes

- Irvine, M.L. 2015: Monitoring coastal change in Newfoundland and Labrador: 2014 update. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report, 15-1, pages 263-276.

- Irvine, M., Catto, N. and Forbes, D 2016: Science for coastal management policy in Conception Bay South, NL. *In* Adapting to Change: a Northeast Avalon study tour, Conception Bay South, NL, October 5, 2016.

- Irvine, M. and Roberts, G. 2017: Exploring the use of UAVs in coastal environments, mining and geotourism. *In* Workshop on high resolution mapping along the coastal zone, Centre of Geographic Sciences (COGS), Lawrencetown, NS, February 8, 2017.

Data collected by repeatedly flying a drone over coastal areas makes it easier to accurately quantify rates of coastal erosion, and to understand the interaction of different factors (rock type, beach composition, and slope) that contribute to erosion.

TS-4 The Newfoundland Ice Sheet Shelf (NISS) Survey - Research Cruise: Bay d'Espoir to Burgeo

*Jennifer Organ, *Paul Dunlop, **Sara Benetti, **John Shaw, ***Trevor Bell*

The Geological Survey participated in the Ulster University-led research survey Newfoundland Ice Sheet Shelf (NISS) project. The survey focused on collecting data on submarine moraine systems at the mouth of fjords between Bay d'Espoir and Burgeo, along the south coast of Newfoundland. This was a unique and exciting opportunity to collaborate with other researchers, and to expand our geological knowledge away from the land-based surficial mapping and sampling. This study looked at how the ice from the Newfoundland Ice Cap, which covered the entire island during the last glaciation, affected the inner continental shelf.

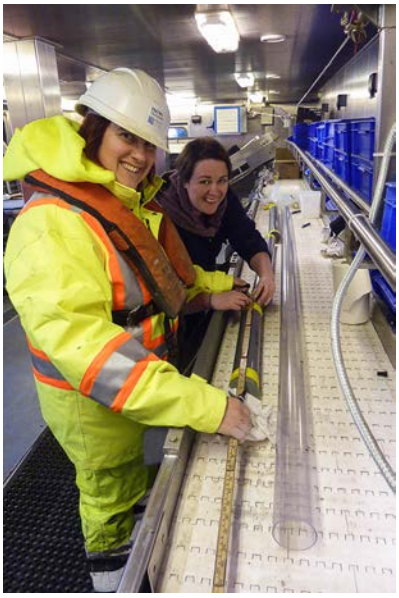
The NISS is a collaboration of researchers from Ulster University, the Marine Institute of Ireland, Geological Survey of Canada, Memorial University of Newfoundland, and the Geological Survey of Newfoundland and Labrador and is funded under the Irish National Research Vessels 2016 'Ship Time' Programme.

The aim is to collect sediment cores using a vibro-corer and gravity corer, from offshore glacial-moraine locations, and to map other fjord mouths using multibeam seabed bathymetry and seismic-profile data surveys.

The survey successfully collected over 100 nautical miles of multibeam seabed bathymetry, backscatter and seismic data, and 37 m of sediment cores from 26 sites of targeted glacial sediments retrieved on fjord-mouth moraines. Material contained within the cores may then be carbon-dated. These data will form the basis of new investigations into the glacial and postglacial development of the southern Newfoundland continental shelf, as well as the timing and pattern of retreat of the Newfoundland Ice Cap during the late Wisconsinan Glaciation 18 000 years ago. In addition, the data contribute to the Atlantic Ocean Research Alliance's Atlantic Seabed Mapping Initiative.

Cover being cleared, and stored.

Capping core liner with the help of the ship's staff.



Labelling core on board ship.

** Quaternary Environmental Change Research Group, Ulster University, Coleraine, Northern Ireland*
*** Geological Survey of Canada - Atlantic, Dartmouth, NS, Canada*
****Memorial University of Newfoundland, St. John's, NL, Canada*

Outcomes

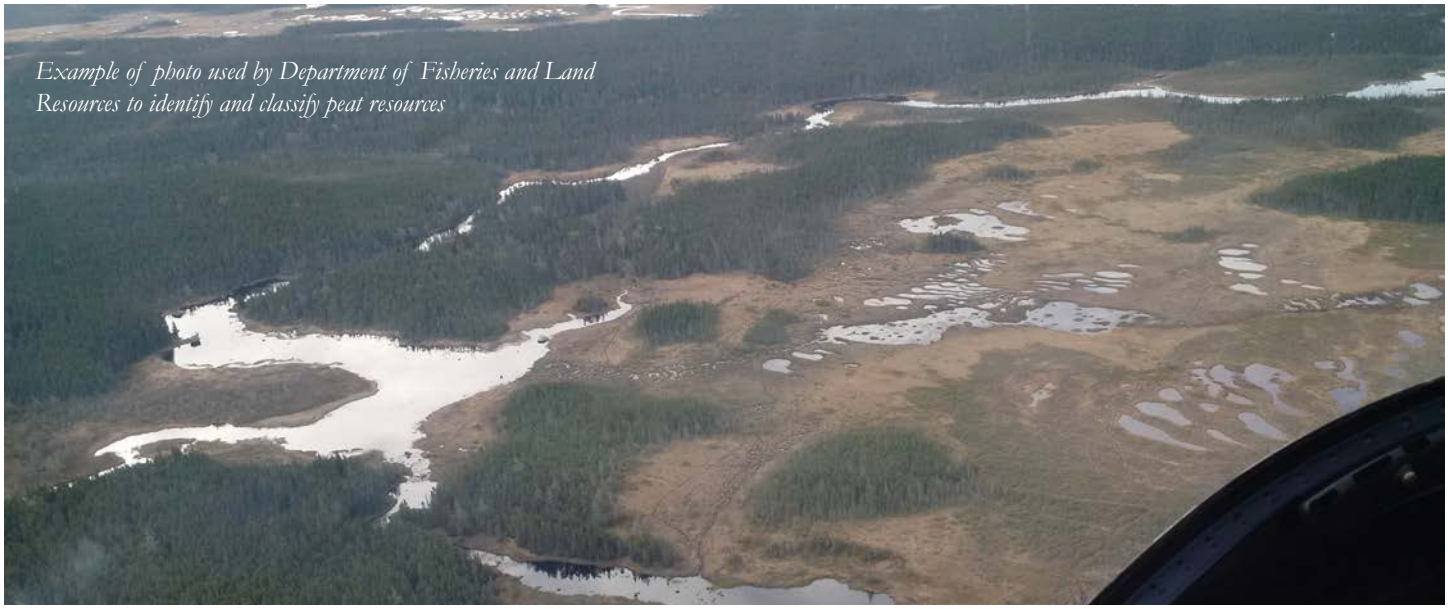
- Organ, J.S. 2017: Cruisin' the South Coast – Bay d'Espoir to Burgeo: The Newfoundland Ice Sheet Shelf (NISS) Survey. Presentation Geological Survey of Newfoundland and Labrador Winter Seminar Series, March 23, 2017.

- Organ, J.S., Dunlop, P., Benetti, S., Shaw, J., Bell, T. 2017: The Newfoundland Ice Sheet Shelf (NISS) Survey – Research Cruise: Bay d'Espoir to Burgeo, Newfoundland. *In* Current Research. Newfoundland and Labrador Department of Natural Resources Geological Survey, Report 17-1, pages 135-145.

- Dunlop, P. 2016: Research Survey Report CE16010, CV Celtic Explorer. The Newfoundland Ice Sheet Galciated Shelf (NISS). Unpublished cruise report, Ulster University, Coleraine, Northern Ireland.

TS-5 Coordination and Integration of Digital Data with the Online Geoscience Database

David Taylor



Example of photo used by Department of Fisheries and Land Resources to identify and classify peat resources

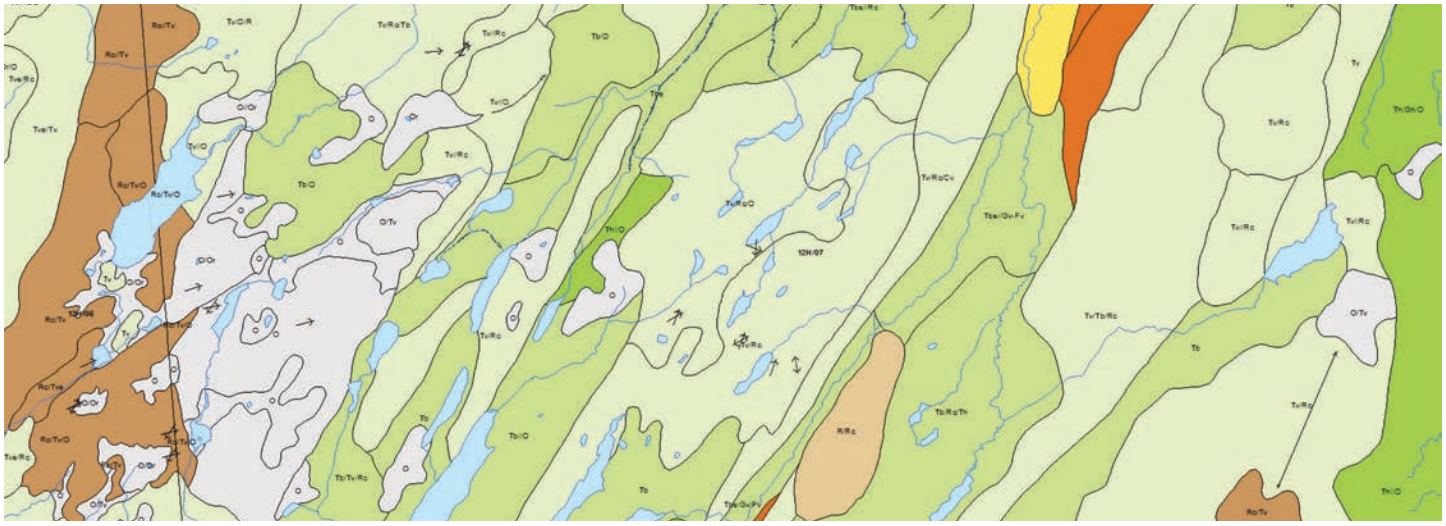
The Geological Survey is converting all its hardcopy 'heritage' data into digital files and putting it into its online Geoscience Database; this includes converting existing surficial geology/ geomorphological data. Existing data includes hardcopy surficial maps, landform structures, till-geochemistry, glacial striation measurements, and aggregate resource potential. All data were captured from paper maps, field note books and various internal and external publications.

To date, all old paper 1:50 000 scale surficial geology maps have been digitized, including 36 000 landform structures, and placed in the Geoscience Database bring the total available maps to 111 for the Island and 38 for Labrador. Currently, the database holds results from 19 000 till-geochemistry samples analyzed for 48 separate elements, 214 aggregate-potential maps (1:50 000 scale) and 12 800 glacial-striation measurements.

In 2015, the Geological Survey initiated a project to scan and rectify approximately 2000, 1:15 840-scale peatland inventory maps for the island. These maps were produced by the Department of Forest Resources and Lands to identify and classify peat resources. To date, 1750 maps have been rectified and placed in the database.

Outcomes

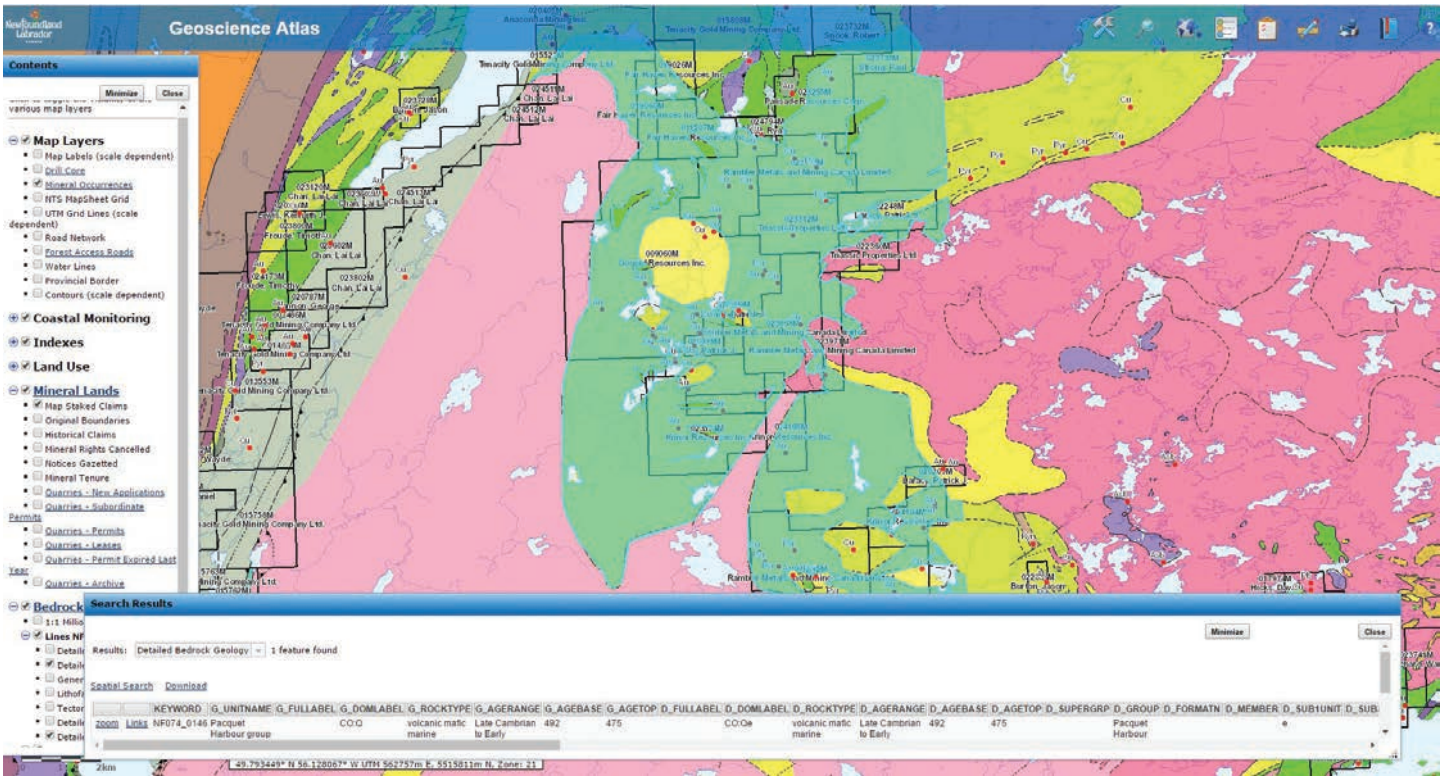
- Converting existing surficial geology data to a digital format for inclusion with the on-line Geoscience Database allowing quick and easy access for user groups.
- Easily identifies areas having inadequate coverage, enhancing planning for upcoming mapping projects.
- Allows for easy and efficient updating of existing datasets.



Surficial geology map showing landform symbols and glacial striation directions.

DM-1 Bedrock Geology Digital Database

Loretta Crisby-Whittle



Until recently, most of the bedrock geology maps of the province were produced and distributed in paper format. Since the late 1990s, the demand has grown for these maps to be made available digitally. The initial process converted all the published maps to digital format. These maps were scanned and made available to the public as 'portable document files ' (pdfs). These pdfs became a popular way to display and deliver the map products to consumers. Also available to the public are 'raster' file images, which can be geographically referenced and spatially displayed within any Geographic Information System (GIS).

Most companies and many individuals are now avid users of GIS software and require digital products. Clients need a geospatial product that can be searched and filtered based on its geographical location, attributes and association with other layers of data from various sources. Geospatial vector files contain point, line and polygon data. All such data were collected, analyzed and interpreted by Geological Survey geologists. Our clients use these vector files as a base on which to display their own findings, as is often the case with prospectors who are promoting their mineral showings. Most of the map-staking follows the trend of mapped Geological units.

The Survey's bedrock geology GIS layers are used by provincial government departments, the federal government, municipalities, students, universities, mineral exploration companies, prospectors, environmentalists and individuals. They are made available worldwide through our GeoScience online web page for browsing or download.

The data are dynamic, serve as a stand-alone product, and are kept to interoperable standards. In other words, the data must maintain their integrity and be verifiable and yet be transferable and comparable to other databases of like information used by clients in other jurisdictions across Canada and elsewhere.

The Bedrock Geology Database consists of the most recent or most detailed maps of the province. These maps have been brought together under a common legend and can be displayed at any scale and by several geological themes but maintain their original source information and level of detail. Clients can customize a display of the bedrock geology for a specific area to suit their specific needs. The data are also searchable based on any one of their many attribute fields.

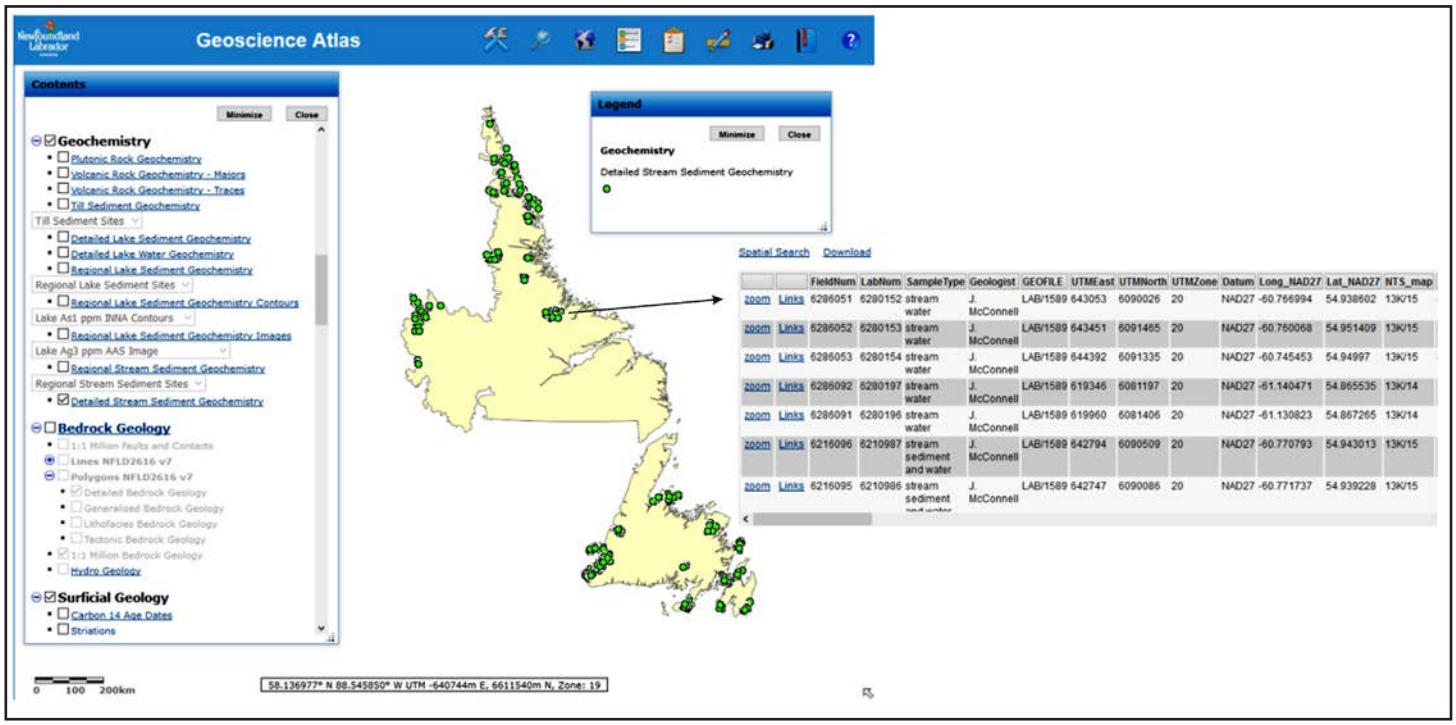
Recently published maps have provided many new age dates. These dates will be added to a Geochronological Database.

Outcomes

- Individual digitized maps are available to clients upon request and updates to the Bedrock Geology Database are posted to the online Geoscience Atlas
- New geochronological data are updated and added as a geospatial layer to the Geoscience Atlas.

DM- 2 Geoscience Knowledge-base for Newfoundland and Labrador

Pauline Honarvar and Shawn Duquet



Effective management of the extensive geoscience knowledge-base for the province is the foundation used by the mineral exploration industry for research and investment, and is becoming increasingly important in ensuring that mineral and industrial development is environmentally sustainable. This requires confidence in the accuracy, currentness and completeness of the database. The application of computers for information management and dissemination offers the only practical avenue for achieving the necessary organization and delivery of information to clients. Much of the geoscience knowledge-base is geographically referenced, hence Geographic Information Systems are essential.

Dissemination of the provincial geoscience knowledge-base is provided through the Geoscience Atlas website, accessed through the Geoscience OnLine portal **(http://gis.geosurv.gov.nl.ca**). Various layers are continuously updated and this year a new stream-sediment and stream-water geochemistry layer was added. This layer consists of 8000 archival samples, collected throughout Newfoundland and Labrador between 1974 and 1995. Each sample has a set of field data as well as numerous geochemical values for such elements as gold, copper, and zinc.

Outcomes

- The addition of new data to the Geoscience Atlas stimulates research and exploration investment in the province as well as providing baseline information for environmental monitoring.

- Honarvar, P., Nolan, L., Crisby-Whittle, L, Roberts, G., and Duquet, S., 2015. The New Geoscience Atlas. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 15-1, pages 287-294. **www.nr.gov.nl.ca/nr/mines/geoscience/publications/currentresearch/2015/Honarvar-2015.pdf.**

- The tutorial for the Geoscience Atlas is available in this pdf: **geoatlas.gov.nl.ca/custom/help/Help_AtlasTutorial.pdf.**