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ORIGINAL ARTICLE

Turning a Forgotten Geological Heritage into a Geological Park: Developing Stonehammer Geopark

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Abstract Stonehammer Geopark, North America's first member of the Global Geoparks Network, developed in a region with a long history of geological exploration and a tradition of public education in the geosciences. The remarkable geological complexity centred on the city of Saint John, New Brunswick, Canada, nurtured a homegrown group of professional and amateur geologists in the early 1800s. Many became internationally known for their work, and the institutions they created were at the forefront of research and public education from the middle nineteenth to early twentieth century. By the 1920s, it had mostly disappeared from the community. By the end of the twentieth century, geoscience heritage was largely a forgotten part of the community's understanding of its past. The creation of a global geopark has brought stories of the region's geology back to the public attention by providing geological interpretation of existing parks and trails that had originally developed largely because of the scenic geology. Storytelling, bolstered by researching the lives and contributions of those people in the community who made the geology internationally known, is seen as an important part of reviving a community sense of its geoscience heritage.

Keywords Geopark · Geotourism · Geoheritage · Stonehammer · Canada

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A 'Splendid Testimonial'

On Friday October 7, 1921, George Frederic Matthew (1837–1923) was invited to a banquet held in his honour at the Union Club in Saint John, New Brunswick, Canada. George Matthew (Fig. 1), a customs agent, was leaving New Brunswick after a lifetime of service. In attendance were Mayor Schofield of Saint John; The Honourable Walter Foster, Premier of New Brunswick; and The Honourable William Pugsley, Lieutenant Governor of New Brunswick. They and many others were not there to honour George Matthew the customs agent, but rather to recognise Dr. Matthew's achievements in science (Bailey 1923). His was an extraordinary career spanning six decades of geological exploration and research. Matthew, the customs agent, was also an expert on Cambrian fossils, who corresponded with the likes of Joachim Barrande (1799–1883) and Charles D. Walcott (1850–1927). The local newspaper reported the banquet as a 'splendid testimonial… given by a representative gathering of men distinguished in intellectual and business spheres of the province' (*Daily Telegraph Saturday 8 October, 1921, p. 5*). In many ways, this banquet represented the culmination of nearly a century of a geoscience presence in Saint John. Much later, in 1964, a university was established in the city with science departments representing biology, chemistry, geology and physics, but at the beginning of the twentieth century in Saint John, George Matthew was amongst the last of his kind, an amateur, self-taught scientist in Saint John who had worked his way to the very top of his chosen field. His scientific career began in the mid-nineteenth century at about the age of 20 and ended early in the twentieth century when he was in his mid-eighties (Miller 2005).

Combining Geology and Heritage

Saint John's historic buildings, its prominence as a nineteenth century shipbuilding centre and its labour history, are a well-

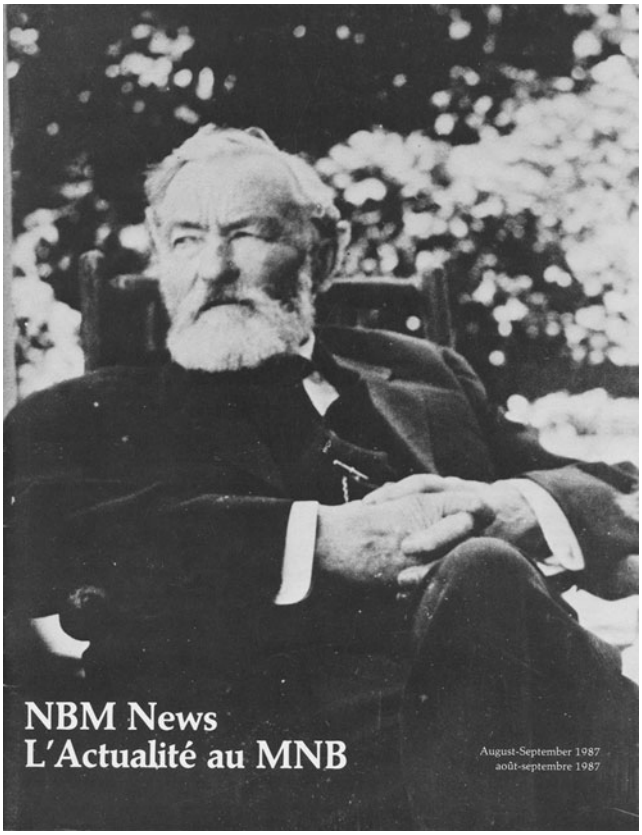

Fig. 1 Dr. George Frederic Matthew, 1921, aged 84 years (NBM 1994.10.1). The photograph was featured on the cover of a newsletter *NBM News* in 1987 during the opening of an exhibition of Matthew's geological work. The Mayor of Saint John declared August 12, 1987 'George Matthew Day' in Saint John

known and proud part of the city's heritage and sense of community. The city has been recognised by the Heritage Canada Foundation with the Prince Of Wales Prize for its commitment to preserving built heritage, Prince William Street has received a 'Designation of National Historic Significance' as a nineteenth century commercial landscape from Parks Canada and Saint John is acknowledged nationally as Canada's oldest incorporated city. However, knowledge that one of the world's first authentic Precambrian fossils (Miller 2003), the first Cambrian trilobites in Canada (Miller and Buhay 1988; Miller 2005), the recognition of Early Cambrian small shelly fossils (Miller 1988) and one of the best known Upper Carboniferous sites of the nineteenth century (Falcon-Lang and Miller 2007a, b) were all discovered and described by local scientists is almost unknown a century after George Matthew left the city.

Given the interest in geology shown by its citizens in the past by both geoscientists and the general public, how did that part of Saint John's story almost disappear from its heritage? The answer is likely simple. For many reasons, stories of geology are often not part of community awareness. Certainly, there are some geological stories that are part of mainstream heritage awareness. Communities with famous dinosaur sites, volcanoes, mines or world-renowned citizens are probably the exception, but in Saint John, the notion that the study of geoscience has been as valid a community contribution as shipbuilding, art, industry or politics was lost over the century since Matthew's retirement.

Saint John has a long history as a blue collar community and one of the industrial centres of eastern Canada. The view that this is all it has ever been is simplistic. Saint John played a significant role in the economic history of New Brunswick and Canada. During the 1800s, the city exerted considerable influence throughout the Maritimes Region of eastern Canada. Saint John merchants controlled trade in the region, and their interests extended across the globe (Acheson 1985). The city has a rich cultural history including theatre and visual arts, literary arts and museums. Less well known is that Saint John has played an important role both nationally and internationally as a centre of scientific study. This paper explores the influence of the complex geology and its early scientific study on the development of a science culture in Saint John. It will also outline steps taken to bring geoscience back into the heritage culture of the city through the Global Geoparks Network.

In 2004, the New Brunswick Museum was part of a research project funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) in partnership with the University of New Brunswick, Saint John. The SSHRC Community–University Research Alliance (CURA) project set out to examine Saint John as an industrial city in transition (MacKinnon 2008). Transitioning perhaps to a new economy, to a new industry, to a new attitude, to a new more ethnically mixed population and maybe even a new way of viewing its place in Canada. One of the New Brunswick Museum's projects was to examine the region's geotourism opportunities.

If Saint John is in transition, are there benefits in its future from its past scientific achievements? What legacy, if any, was left by the rich scientific culture that developed in Saint John in the 1800s? Is there a geoscience legacy, or is it simply a forgotten part of the city's history?

The Geoscience Legacy

Exploration and exploitation of the local geology goes back to a history of mining local marble in the eighteenth century to make quicklime (Fig. 2). It was one of the reasons Europeans settled the Saint John area (Acheson 1985). Although mining is a small part of the local economy today, Saint John's limekilns operated throughout the nineteenth century. Graphite mines were opened in the centre of the city, and small dimension stone quarries were opened in the Precambrian marble to construct local buildings. Today, quarrying for

agricultural lime continues, and the Port of Saint John is the shipping terminal for a large potash industry in southern New Brunswick. Canada's largest oil refinery and the first liquefied natural gas terminal in Canada sending natural gas to Canadian and US markets are located in the city.

The first record of which we know concerning the public promotion of geological sciences occurred in 1824 when Dr. William Hunt delivered a series of public lectures in Saint John on topics of geology (*New Brunswick Courier, December 20, 1823; City Gazette, February 5, 1824*). We know little of Hunt other than he was an American physician and artist who spent some time in Saint John. Hunt was but the first to bring geology to the citizens of Saint John. Abraham Gesner (1797–1864), often considered a founder of the modern petroleum industry for his discovery of a kerosene distillation process (Beaton 1955; Brice 2002), moved to Saint John in 1838 (Fig. 3). He was New Brunswick's first Provincial Geologist, the first such appointment in the British Empire. His collection of New Brunswick rocks, minerals and fossils is likely the second oldest government survey collection in the British Empire (Miller et al. 2012) and was part of a geological museum he opened in 1842 (Miller and Buhay 2007a). 'Gesner's Museum' opened 9 days before the founding of the Geological Survey of Canada and was one of the first public museums in the country. Gesner lectured frequently about geology at the Saint John Mechanics' Institute in the late 1830s to early 1840s, as did his contemporary Robert Foulis (1796–1866) who was also interested in geology (Wright and Miller 1990). The newspaper reported that Edouard de Verneuil, President de la Société Géologique de France, visited the Mechanics' Institute Museum in 1846 where he viewed Gesner's collection (*Novascotian–May 24, 1846*). Charles Lyell (1797–1875) was in Saint John in 1852, and the local newspaper covered his travels and geological observations in the city (Miller and Buhay 2007b).

In 1857, a small group of young men in their late teens to early twenties formed the Steinhammer Club (Miller and Buhay 1988). They were new to geology but keen to discover what they could about the complex rock structures in their city. With its cultural ties to Great Britain, nineteenth century Saint John developed with traditional Victorian science values. The Steinhammer Club was driven by the enthusiasm of dedicated members, in particular George Matthew, who became Canada's Cambrian fossil expert (Miller 2005) and Fred Hartt (1840–1878), who went on to Cornell University and led a geological survey of Brazil for many years (Brice 1994). William Dawson (1820–1899), Canada's most influential scientist of the time (Phillipson 1988), mentored club members. Dawson was Principal of McGill College (University) in Montreal, author of the classic Canadian geological work *Acadian Geology* (Dawson 1868) and a key member of the Natural History Society of Montreal.

Fig. 2 Armstrong Lime Quarry, c 1890–1910, Green Head Island, Saint John, New Brunswick (NBM X16706-143(2)). The remains of the quarry are highlighted on a guided Stonehammer Geopark kayak tour

Dawson encouraged Steinhammer Club members to create the Natural History Society of New Brunswick (1862–1932). During its tenure, the Society published a widely distributed scientific journal sent to societies and academic libraries in North and South America, Europe and Australia (McTavish 2013), had members who corresponded with colleagues across North America and Europe, developed research collections, presented member and invited lectures to the Society

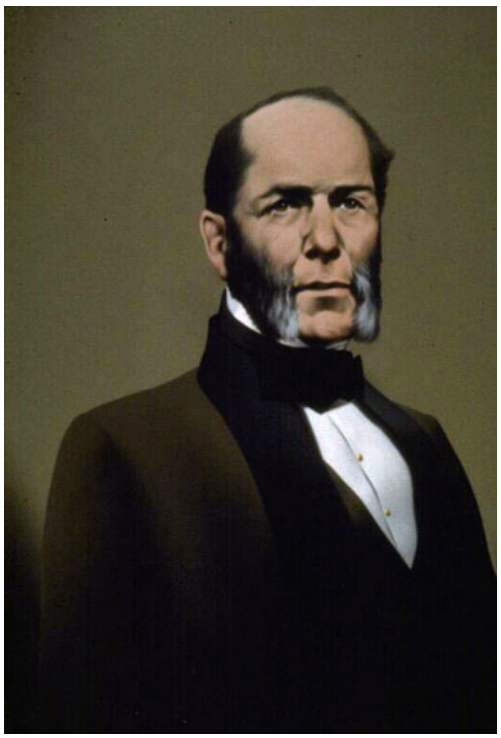

Fig. 3 Abraham Gesner (1797–1864) is considered a founder of the modern petroleum industry for his discovery of a kerosene distillation process. Painting, oil on canvas, by Canadian artist Lawren Phillips Harris, 1960 (New Brunswick Museum 1979.120)

and the public, held summer field camps, published research results in the leading scientific journals, had members elected to the Royal Society of Canada and made discoveries of international significance (Matthew 1913). From its foundation, geology and the geologist members, including former Steinhammer Club alumni, played a pivotal role in maintaining and moving the Society forward (Miller and Buhay 1988). Many of its most significant scientific discoveries were in the fields of geology and palaeontology, and at times, society members and the public heard lectures on the cutting edge of research in those fields. During most of second half of the nineteenth century, the city had both an active Mechanics' Institute and a Natural History Society along with their museums and libraries (Buhay and Miller 2010).

The society's activities culminated in 1932 with the opening of the new provincial museum (Fig. 4) dedicated to New Brunswick history, the visual arts and natural history. The Natural History Society of New Brunswick transferred its collections, including 'Gesner's Museum', to the Province. In spite of the museum's geological origins when the New Brunswick Museum was founded, it had no geologist. A curatorial position for geology was not created until 1986.

Fig. 4 New Brunswick Museum, c 1934 (NBM 1989.83.339). The Provincial Museum built in Saint John in 1932 became the home to the collections of Abraham Gesner, the Mechanics' Institute and the Natural History Society of New Brunswick

A Forgotten History Amid Complex Geology

Why did geology become pivotal to the development of a science culture in Saint John? Part of that stems from the remarkable geological history found in the region. Few cities can compare when it comes to the complex geological diversity seen within its limits (Miller 2011; Miller and Falcon-Lang 2012). A walk through the city takes you through a billion years of earth history (Fig. 5). Rock outcrops are a prominent feature on the landscape. The geological complexity places sedimentary rock against metamorphic rock, igneous rocks intruded through pre-existing bedrock and exceptional fossils representing major events in the evolution of life, all within a short walk of the centre of Saint John. As local geologists explored and developed their skills, they never had to leave the city to experience a full range of geological features.

Modern principles of the science of geology were relatively new when Abraham Gesner began his survey of New Brunswick in 1838. Only a few years later in 1842, Gesner took Charles Lyell, one of the founders of scientific geology, on his first visit to the famous Joggins locality in Nova Scotia (Calder 2006). In 1852 when Lyell visited Saint John, it had only been two decades since he had published his groundbreaking work *Principles of Geology* (Lyell 1830) that laid out the fundamental rules of geology. In 1936, almost 100 years after Gesner began to study the geology of Saint John, Geological Survey of Canada geologist F.J. Alcock (1888–1972) began his Memoir on the geology of Saint John by writing 'Perhaps no other area of similar size in Canada has presented so many geological problems as has that which includes and immediately surrounds the city of St. John, New Brunswick.' (Alcock 1936, p 1). It was into this mix of rocks with multiple terranes, folded and faulted sequences and complex fossil assemblages that Gesner and the Steinhammer Club followed their desire to be geologists.

Matthew and Hartt had not turned 20 when they began their first explorations of the city's geology. Within 5 years, they had discovered the oldest trilobites in Canada and what were then believed to be the oldest insects in the world (Fig. 6). William Dawson and William Logan (1798–1875), Director of the Geological Survey of Canada, both called upon them for assistance. While they had few resources to support their work, they did have a world of geology at their doorstep, from the Late Precambrian through to Triassic, all topped by

Fig. 5 Rock outcrops such as the Precambrian–Cambrian section at Somerset Street, Saint John, exhibit a remarkable and accessible record of Earth history. This section with radiometric dates is a key site for global Cambrian correlation (NBM)

Neogene deposits of the last ice age. We speculate that had they begun their geological quest elsewhere they might not have been as fortunate. Field work in and around the city was easy, outcrops abundant, and the diverse geology allowed Matthew and Hartt to make major discoveries. Dawson was so impressed with the work of Hartt (1865) and Matthew that he used their work concerning Cambrian trilobites and the geology and palaeontology of the Upper Carboniferous (originally believed to be Devonian) 'Fern Ledges' in the second edition of his monumental work, *Acadian Geology* (Dawson 1868). Hartt, along with Samuel Scudder (1837–1911) of Boston, had described insects from the Fern Ledges site (Scudder 1880).

Matthew (1863) wrote one of the first papers describing the geology near Saint John and geologists from the Geological Survey of Canada (Fig. 7) mapped the regional geology and studied fossils from the late 1800s through to the early 1900s (Alcock 1936; Hayes and Howell 1937). During this period, many of the survey's best scientists visited the city including Henri Ami, Robert Chalmers, Robert W. Ells, Hugh Fletcher, Lawrence M. Lambe, and Albert P. Low (Zaslow 1975). All of these skilled scientists made the life of a geologist in Saint John very exciting. They published their results in regional, national and international research journals and in reports of the Geological Survey of Canada. Their sometimes differing opinions sparked heated debates about the interpretation of the geology and drew in experts from other parts of the world (Falcon-Lang and Miller 2007a). The famous American palaeontologist Charles Doolittle Walcott made a number of visits to Saint John in the 1800s to work with George Matthew (Yochelson 1998), with whom he had a disagreement about the nature of the early Cambrian fossil record. In 1910–11, Marie Stopes, famous for her work in birth control and her 1918 book about sex called *Married Love* (Rose 1992), came to Saint John to practice her less known career as an outstanding palaeobotanist and to resolve a bitter debate concerning the age of the rocks on the Bay of Fundy shore in west Saint John. Stopes (1914), once and for all, determined the age of the Upper Carboniferous Fern Ledges shales (Falcon-Lang and Miller 2007a, b).

Stories of major geological interest about Saint John include the discovery of a stromatolite fossil (Fig. 8), the first Precambrian stromatolite to be scientifically described (Miller 2003) from late Precambrian marble at Green Head in the north end of the city. Matthew described the Cambrian–Ordovician rocks that underlie the city centre in dozens of publications. In rocks just east of the city where Hartt, Matthew and Professor Loring Bailey (1839–1825) of the University of New Brunswick had discovered Cambrian trilobites (Dawson 1868), Matthew described enigmatic 'Small Shelly Fossils' from rocks at the base of the Cambrian Period from a Paleozoic unit he called the Etcheminian (Matthew 1890, 1899). Matthew's young son William, later a world-renowned palaeontologist at the American Museum of Natural History, found one of the world's largest trilobites in Cambrian rocks near the Saint John harbour (Matthew 1888; Miller 1994). Studies of stratigraphy and palaeontology of the same rock outcrops George Matthew studied are still part of ongoing global efforts to define divisions within the Cambrian and have been described in recent years in the Canadian Journal of Earth Sciences, Atlantic Geology, Earth Science Reviews, Journal of Paleontology, Palaeontology among others. Hartt also compiled a list of ice age fossils for Loring Bailey. On the strength of his work in Saint John, Hartt later studied with Louis Agassiz at Harvard and went on to become the first professor of geology at Cornell University (Brice 1994).

Science, Saint John and the 1800s

An analysis of scientific publication in the Maritimes of Canada prior to 1914 determined that from 1860 to 1905 geology led the sciences in the number of scientific papers produced in the region (MacDonald 1990). Of the forty most prolific authors counted, George Matthew led the field and in New Brunswick geology ranked first in the number of published papers. While the University of New Brunswick in Fredericton taught natural history, more science authors were located in Saint John. The turning point for the increasing number of publications in New Brunswick occurred in the mid-1880s when the Natural History Society published their first Bulletin in 1882. Prior to 1880, a total of 63 scientific papers were published in New Brunswick. Between 1880 and 1913, publications for each 5-year interval never dropped below 53 and reached 100 for the period 1895–1899.

The Mechanics' Institute and the Natural History Society had active lecture series, both for their members and the public, and lectures were often reported in the local newspaper. Lecturers at the Mechanics' Institute included leading regional scientists like Gesner, who delivered the inaugural lecture, Foulis and geologist James Robb (1815–1861) from the University of New Brunswick. Agricultural scientist James Finlay Weir Johnston (1796–1855) travelled from England to lecture to the Institute on 21 December 1849 on the agricultural capabilities of the province. Acheson (1985) reported that Harvard botanist Asa Gray (1810–1888) also lectured to the Institute. Hewitt (1988, 1990) recounted a lecture by Gesner to an audience of 900 people at the Mechanics' Institute, involving the passing of an electrical current through a decapitated ox's head to demonstrate 'galvanism'. His other lectures, although often less graphic and stimulating, introduced eager citizens to a world of science in the early 1800s.

The Natural History Society of New Brunswick continued the tradition of offering scientific lectures to its members and

Fig. 6 An extraordinary fossil record exists in the Saint John, New Brunswick area: *left* Cambrian trilobite *Ctenocephalus matthewi* (NBMG 13242) named for George Matthew (image width 1.2 cm); *right* Upper Carboniferous insect wing *Lithentomum hartii* (NBMG 3015) named for Fred Hartt (image width 6 cm)

the public. During the period 1862 to 1913, there were at least 709 lectures read before society members and 104 elementary lectures delivered before a pubic audience (Buhay and Miller 2010). Of those, 192 were geology and palaeontology lectures to the society and 17 elementary lectures on similar topics for the public. Society lectures also covered topics dealing with archaeology, chemistry, physics, meteorology, botany and zoology. Lectures often reported on topics of current scientific interest. Examples include an 1863 lecture by George Sinclair on 'Certain Theories concerning the Origin of Species' and a paper read in 1868 by C.K. Fiske on behalf of the corresponding member of the society Louis Agassiz from Harvard College concerning the 'Fossil Tooth of an Elephant from Japan' (Matthew 1913). Lectures delivered by active scientists in the society reported on their own work and were often at the leading edge of scientific discovery. In 1890, George Matthew lectured on the discovery of the Green Head stromatolite (Miller 2003). The audience would not have known at the time, but they were the first in the world to hear of the discovery of life in the Precambrian. Matthew also lectured to the society about reptile and amphibian footprints where he was at the leading edge of research. Matthew identified dubious footprints from the Fern Ledges site in Saint John, but he also examined fossils from the famous Joggins locality in Nova Scotia. His work set the pace for the study of Carboniferous footprints (Matthew 1903) by attempting to develop a classification framework for tracks. More than a century after Matthew's work, there has been little progress in finding a suitable classification scheme (Haubold et al. 2005). Matthew delivered a number of elementary lectures for a public audience including the 'Fossil Botany of the Palaeozoic Rocks, with special reference to the coal measures and plant bearing beds at St. John' in 1894 (*Natural History Society Bulletin XIII, 1896, p. 103*) and the next year a public lecture on the

Fig. 7 Group of geologists sitting on the ground with horse drawn carriages in the background near Saint John, New Brunswick, c 1898. The geologists look like (*left to right*) G.F. Matthew, A.P. Low, H. Fletcher, and possibly W.F Ferrier and G.A. Young. Reproduced with permission of Natural Resources Canada 2013 courtesy of the Geological Survey of Canada (no. 1614)

Fig. 8 In 1890, *Archaeozoon acadiense* (NBMG 3100) became the first Precambrian stromatolite properly described in a scientific journal (image width 19 cm)

'Geological History of the invertebrates' (*Natural History Society Bulletin XIV, 1896, p. 60*).

The Natural History Society organised field trips for its members. In 1913, the International Geological Congress was held in Toronto and as part of the pre-Congress field trips the Geological Survey of Canada determined that Saint John would be one of the locations it would visit. Much of the palaeobotanical work by survey geologist W.J. Wilson (Miller and Brazeau 2007) and the survey's revision of the Fern Ledges by Stopes (Falcon-Lang and Miller 2007a) were done in advance of the Congress field trip. Since then, Saint John has remained a regular destination for professional field trips and university training.

Public Face of Geoscience

Our experience in public education at the New Brunswick Museum in Saint John suggests that few people outside the specialist community of geoscientists know about the geological work that was conducted here. Since 1921, when Matthew was honoured by his peers for the attention he had brought to the city, awareness of that aspect of the community has all but disappeared. Popular history has focused on Saint John being Canada's oldest incorporated city, its heritage buildings, its labour history and on its shipbuilding history exemplified by the clipper Marco Polo built in Saint John in 1851. The Marco Polo was once considered the fastest ship in the world sailing from Liverpool, England to Melbourne, Australia, in 76 days, a voyage that had normally taken 100 to 120 days.

The hundreds of lectures delivered by the Mechanics' Institute and the Natural History Society and its visitors certainly reached an audience of interested individuals. Between 1862 and 1913, the Natural History Society delivered almost 16 each year. With more than one a month available to Saint John's citizens, lectures were regularly advertised and reviewed in the local newspapers. Active member and public use of the society's resources sustained the lecture series of the society. Following the demise of the Natural History Society, the New Brunswick Museum continued exhibiting collections and maintaining public programmes in science. Museum curator William MacIntosh (McTavish and Dickison 2007) was well known for his naturalist outings. Geology education and popularisation in Saint John however was lost and became the work of geology departments at the University of New Brunswick (Fredericton) and Mount Allison University (Sackville), the Provincial geological survey (begun by Gesner in Saint John, but relocated to Fredericton) and the Geological Survey of Canada in Ottawa.

The 'Stonehammer' in Geopark

By 2004, when work began to examine the geotourism opportunities in Saint John, nearly a century had elapsed since Matthew's retirement dinner. By the start of the SSHRC-CURA project, the New Brunswick Museum had almost 20 years of rebuilding its geological programmes, researching geoscience exploration in the city and organising its collections. Much of the museum's background work for a geotourism study was complete. During those two decades, a permanent geology gallery had been opened at the museum, several temporary and travelling exhibitions had come and gone and the media coverage of local geological activities had begun to rise. As part of a George Matthew birthday celebration by the museum in 1987, the mayor of Saint John proclaimed August 12 that year as 'George Matthew Day' in Saint John (Fig. 1). It was clear that one of the impediments to the community recognising its geoscience heritage was simply awareness and 'storytelling', not apathy. Anecdotal evidence suggested that an undercurrent of 'awareness' existed amongst the citizens to some degree. One of the prominent landmarks in Saint John is the Reversing Rapids (or Reversing Falls as it is sometimes called) (Fig. 9). In postglacial time, there was a series of waterfalls at the mouth of the St. John River. The river dropped down from a lake dammed up behind a rock ridge and flowed out to the bay. About 3,000 years ago, the rising tides of the Bay of Fundy (the highest recorded tides in the world) were enough to drown the river mouth at high

Fig. 9 Rock outcrops in the Saint John area exhibit a remarkable record of Earth history including the Precambrian–Cambrian terrane contact at the Reversing Rapids: *left* outcrops viewed from a tour boat (Stonehammer Geopark collection); *right* Saint John River at Reversing Falls watercolour painting by William Land Scarnell, 1864 (NBM 1967–120)

tide causing the phenomenon of the Reversing Rapids as the river reverses flow with the rising tide. It has been a tourist attraction since the 1800s at least. Charles Lyell wrote about it to his father-in-law in 1852 (Lyell 1881). However, the nature of bedrock geological structure has been relatively obscure for most visitors. In fact, the rocks of the gorge are at least as interesting as the postglacial story. The river crosses a terrane boundary here at one of the main bridges linking east and west Saint John, flowing over the Precambrian Brookville Terrane (Ganderia), across the Caledonia Fault and onto the Caledonia Terrane (Avalonia). It was a local rumour that a 'little piece of Africa' and a 'fragment of South America' could be seen in Saint John.

The CURA project, to examine geotourism, developed at the same time that the geopark network was going global. The UNESCO assisted Global Geoparks Network (GGN) held its

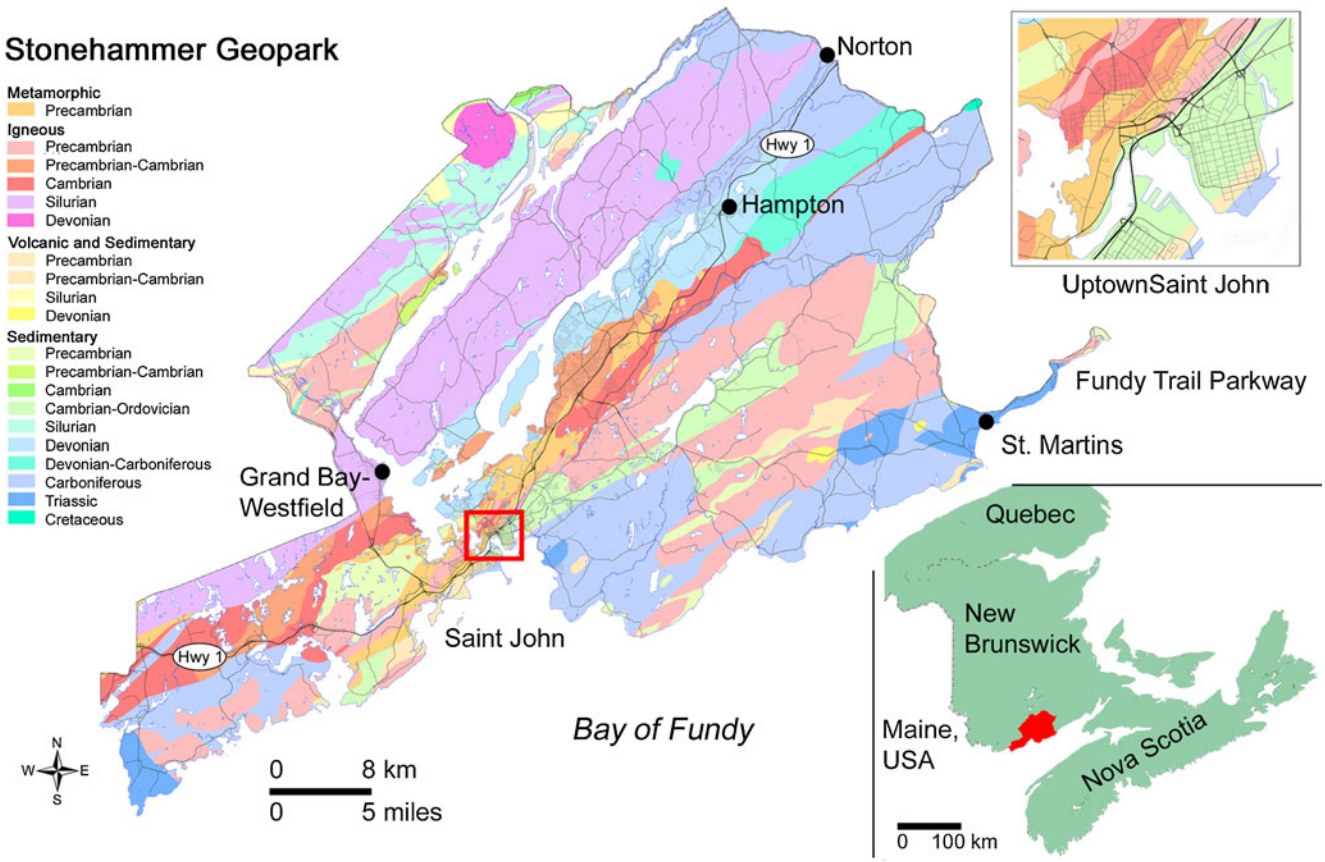

Fig. 10 Geological map of Stonehammer Geopark in southern New Brunswick, Canada, a member of the Global Geoparks Network. The geopark encompasses 2,500 km^2 and comprised of more than 100 geological formations and igneous suites

Fig. 11 Stonehammer Geopark sign at Fallsview Park in Saint John describing the Reversing Rapids (Stonehammer Geopark collection)

first international meeting in Beijing in 2004. By 2006, an aspiring geopark centred on Saint John had been outlined by the New Brunswick Museum, and in 2007, a concept for a geopark, based on the regional geology and history of exploration was presented through public lectures at the New Brunswick Museum, at meetings of community groups and through local media. The response was overwhelmingly positive, and in September 2009, an application to create Stonehammer Geopark was submitted to the GGN and UNESCO (Fig. 10). Perhaps, the most interesting part of the story is how quickly community members embraced the concept of a geopark and recognised the significance of the local geoheritage. From an initial show of support to create a 'geopark' committee to a completed application took a relatively short time. Generating community support, creating a memorandum-of-understanding with each partner park and community, developing a geosite list and management plan, building a governance structure and raising funds all happened within 20 months, all with volunteer support. Certainly, the promise of economic development through geotourism was a draw for stakeholders, but the realisation of a significant geoheritage was important. In 2010, Stonehammer Geopark became the first North American member of the Global Geoparks Network. The park name was derived from the Steinhammer Club, the geology club formed in 1857, a deliberate reminder of local geoheritage. Stonehammer Geopark tells 'a billion years of stories' of Earth history and 175 years of geological exploration (Miller 2011; Miller and Falcon-Lang 2012). The strategy for Stonehammer Geopark was to link existing parks and trails under a common geological theme. About 60 significant geological and fossil locales across 2,500 km^2 currently comprise the park (Fig. 11). The scenic landscape had already resulted in a rich mosaic of parks depending on geology for their beauty, but with little prior interpretation of the rocks. About a dozen of the geosites key to Stonehammer Geopark are publicly accessible (www.stonehammergeopark.com). The geopark was planned to make use of existing infrastructure that includes two provincial parks, seven municipal parks, a private park and a public museum (Fig. 12), also a deliberate attempt to add geological interpretation to places already familiar to the community and funded independent of the geopark. Other small parks, nature preserves and trails offer additional geological stories. Each park offers a unique geological story, along with its own management, tourism and recreation focus, creating a varied geopark. Dozens of other geosites on public lands display many geological features, including significant fossil sites, from more than 100 formal geological formations and igneous suites found in the park. Stonehammer's management plan ranks geosites as suitable for tourism, public education, or specialist and research visitation.

Fig. 12 View of the Triassic geology along the Fundy Trail Parkway, a Stonehammer Geopark partner. An interpretive panel at the lookout describes coastal erosion and the formation of the 'flowerpot' (NBM)

Recognition of a Geoscience Legacy

Beyond the continuing study of science, what can Saint John do with its rich scientific heritage? Stonehammer Geopark has shown the community that it has a significant geoscience legacy not only its geology but also the contributions its citizens have made to the study of geology. Stonehammer Geopark began as, and continues to be, a 'grass roots' organisation ensuring efforts have a positive, sustainable impact on the community whether it is through education, providing quality experiences, sustainable economic development or preservation. A developing role for geotourism has been introduced for the ongoing economic development of the region. Local and regional tourism development agencies have joined to promote the geopark and develop partnerships to market geotourism. Stonehammer Geopark received the 2011

Fig. 13 A kayak tour by a local 'experience provider' takes visitors to see Precambrian stromatolites and a nineteenth century lime quarry (Stonehammer Geopark collection)

Deloitte Innovator of the Year award from the Tourism Industry Association of Canada.

Geotourism definitions range from a global view of tourism to a more focused perspective followed by Stonehammer Geopark where the definition of Geotourism is 'The provision of interpretative facilities and services to promote the value and social benefit of geologic and geomorphologic sites and their materials and to ensure their conservation, for the use of students, tourists and other casual recreationalists' (Hose 2000). Geotourism, based on the observation and understanding of geology, is a growing part of the tourism market. While geotourism is not new, the development of the European Geoparks Network and the UNESCO sponsored Global Geoparks Network are providing models for engaging the public in the appreciation of geology that link sustainable economic development with the preservation and interpretation of geology. We think of geotourism destinations as sites with spectacular landscapes and obvious interpretive and geological impact, but there are other opportunities to incorporate less obvious geological stories into the tourism and public realm.

Interest has come in part from the tourism industry, seeking to enhance a product that includes exploitation of cultural and natural attractions in a market that strives to provide unique, value-added experiences for visitors. In Saint John, boat tours of the Reversing Rapids have incorporated the geological story of the gorge into their traditional interpretation of the tides (Fig. 9). Kayak tour guides are seeking information about geology to enhance their stories of the natural and cultural landscape (Fig. 13). Trail designers are looking for information to develop interpretive signs along walkways. Tour operators working the cruise ship market have added tours of geological sites for ship passengers. Saint John offers the geology, but perhaps more importantly, it offers the history of science and exploration. We have tried to put these stories of geology and discovery before the public as a fascinating part of the region's cultural history. Our strategy for encouraging a geotourism option for Saint John includes research and development of human-interest stories. Viewing the act of the 'study of geology' as important as the rocks reminds us that geoscience is part of society. This region has promoted its shipbuilding heritage and stories of owners, builders and sailors. The same cannot be said of its geoscience heritage and the people who explored and interpreted the rocks.

Nevertheless, geoheritage stories captivate the public and perhaps the key to the Stonehammer Geopark success has been to add 'personality' to geoheritage and add it to the overall sense of community. The Upper Carboniferous geology of west Saint John has puzzled geologists for 150 years. Synthesising the science into a 30-min tour can be difficult, but who is not intrigued by the work of a colourful character like Marie Stopes (Falcon-Lang and Miller 2007a), both a pioneering female palaeobotanist and a pioneer in the sexual revolution and her efforts to reconcile a bitter debate about fossils and the age of the Fern Ledges.

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