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Tracking the Fossil Footprints and Letters of Science from Doctor E. F. Harding in Windsor, Nova Scotia: 1842-1855

Tim Fedak

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Article abstract

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Tim Fedak Tim.Fedak@novascotia.ca

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Résumé : *Trois lettres manuscrites du Dr Ebenezer Fitch Harding à J. W. Dawson, entre 1845 et 1855, fournissent un exemple de la nature « collective » de la géologie naissante. Le Dr Harding était médecin à Windsor, en Nouvelle-Écosse, lorsqu'il a accompagné Charles Lyell lors de sa visite des sites géologiques et des vasières du bassin Minas, dans la baie de Fundy, à l'été 1842. Les lettres couvrent la période de l'aube de la géologie en Nouvelle-Écosse et donnent un aperçu des intérêts personnels du Dr Harding, de sa contribution à la science et de ses relations avec Dawson à Pictou, en Nouvelle-Écosse. L'examen des lettres transcrites documente cette période importante du secteur de la géologie en Nouvelle-Écosse, démontre les liens entre la Nouvelle-Écosse et Édimbourg, et permet de considérer le développement du langage visuel de la géologie en Nouvelle-Écosse.*

Keywords: Citizen Science, History of Geology, Nova Scotia, John William Dawson

> The year 1842 forms an epoch in the history of geology in Nova Scotia. In that year Sir Charles Lyell visited the province, and carefully examined some of the more difficult features of its geological structure, which had baffled or misled previous inquirers. Sir Charles also performed the valuable service of placing in communication with each other, and with the geologists of Great Britain, the inquirers already at work on the geology of the province, and of stimulating their activity and directing it into the most profitable channels.[1]

Marking geologist Charles Lyell's first extended visit in 1842 as the dawn of a new epoch in Nova Scotia geology, J.W. Dawson in his book *Acadian Geology*—itself a monumental accomplishment for the science and culture of geology in the province—recognized that Lyell's visit spurred the growth of a nascent geological community. Dawson intended the book to further act as a bridge, to

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provide citizens of Canada's maritime provinces[2] with "a popular account of the more recent discoveries in the geology and mineral resources" of their region, highlighting that Nova Scotia was "a very interesting portion of the American continent."[3] Charles Lyell's visits and Dawson's *Acadian Geology* bookend an especially productive period of geological inquiry and community-engaged science in Nova Scotia.

Recent work in this journal has examined the diffusion of Charles Darwin's concepts of evolution among Nova Scotia natural scientists after publication of Origin of Species in 1859.[4] This article focuses on the preceding period, between 1842 and 1855, when the modern geology worldview of an ancient earth was becoming popularized through the work of Charles Lyell and citizen scientists working in Nova Scotia.[5] Interest in Nova Scotia geology had initially focused on mineral studies by New England geologists from 1822 through 1835. When Charles Lyell published the *Principles of Geology* in 1830-1833 it inspired a growing interest in the geology of Nova Scotia, and the emergence of a collaborative scientific culture among the physician-geologists of the Minas Basin and workers in the coal fields of Pictou and Cape Breton. Geological formations were increasingly recognized as being ancient rocks that represented records of ancient life. When Lyell arrived in Nova Scotia in 1842, as described in his *Travels in North America,*[6] the components of a 'collective' culture of geology were well at hand.

This article focuses on this emerging culture in Nova Scotia, particularly how it was generated by citizen scientists in and around Windsor and the Minas Basin: it is evidenced in three letters written by a physician-geologist, E. F. Harding, to J. W. Dawson, between the time of Lyell's visit in 1842 and Dawson's publication of first edition of *Acadian Geology*. Dawson and Harding were at the centre of a new collaborative enterprise in geology that citizens, regional and international scientists, and institutions of science created in the province in the mid nineteenth century.[7] Within this culture, the city of Edinburgh appeared as a locus of common educational training for Nova Scotians, as well as the production of geological knowledge and theorizing, as personified in Charles Lyell. This project is part of a larger review of Nova Scotia geology (1820-2020) that considers the 'culture of geology' and its impact on the culture of geology in Britain.[8] These letters suggest, in this historical context, how that culture came to be.

Nova Scotia Geology 1820 – 1840

The foundations of the culture of geology in Nova Scotia was 'collective' in several ways. Studies were based on *collections* of samples obtained during field examinations, but geology was also collective in that this work was often a *collaborative* activity shared among groups of individuals who shared an interest in geology knowledge. As well, the Mechanics' Institutes established in Nova Scotia were social institutions established for the collective learning of members and the general public. Individuals specializing in geoscience also established

personal networks with local citizen-scientists to share information through letters and exchanging of collected specimens. These popular and academic foundations in the science of geology in Nova Scotia would be followed by strategic development of public museums and university programs as well as growing economic and political interest in geology exports in the second half of the nineteenth century.[9]

Between 1820 and 1840, the history of Nova Scotia geology was greatly influenced by contributions from New England geologists. The earliest description of mineral collecting sites in Nova Scotia traces back to reports from Solomon Thayer from Maine. Thayer visited several sites in the Basin of Mines (now Minas Basin, Bay of Fundy) between 1818 and 1822, and Thayer's letters were then tabulated and published by Parker Cleaveland in 1822.[10] Travelling into the Bay of Fundy during the Age of Sail was an incredible adventure, with powerful tides that we now recognize as the highest on the planet. Names of the landmarks for the sailing vessels which made their way into the busy shipping port of Windsor, Nova Scotia, acknowledge the dangers of the area, including Cape Split where the tidal rip forms whirlpools and shearing waves, and the famous Cape Blow-Me-Down (now Cape Blomidon) that was the backdrop to life in the Land of Evangeline.[11]

From Boston, Charles Jackson and Francis Alger followed up on Thayer's initial surveys with several visits to Nova Scotia in 1826, 1827, and 1829. Jackson was studying medicine but spent summer vacations in Nova Scotia with his friend Francis Alger collecting minerals and studying the regional geology. Alger had already visited Nova Scotia with his father looking for iron mines.[12] Jackson and Alger's work resulted in the earliest published fossil from Nova Scotia (*Asaphus crypturus,* Green 1834), the first geological map of Nova Scotia and publication of picturesque depictions of the coastal geology exposures. [13] While in Nova Scotia, Jackson and Alger visited and communicated with Thomas Haliburton, the prominent judge and author who lived at Clifton on the hill overlooking Windsor. Jackson and Alger's work immediately inspired a group of students and professors from Williams College in Williamstown, Massachusetts, to visit Nova Scotia in the summer of 1835. The Williams College trip included visits to Windsor and the detailed description of the trip was published Boston travel writing. They explored the local geology, and described in detail their travels, meeting local dignitaries and visiting geology sites.[14]

At the same time, local geological knowledge was growing in Nova Scotia, primarily in areas with mines. Windsor's gypsum quarries attracted attention from local geology enthusiasts while coal mines around Pictou and Sydney offered opportunities to develop knowledge about coal formations and the industry that developed around their exploitation.[15] This work was summarized within Thomas Haliburton's "Statistical and Analytical Account of Nova Scotia" published in 1829 with a large fold-out map in the first volume, and in the second volume, a summary of the "Geology and Mineralogy of Nova Scotia"[16] written by Robert Brown of the province's General Mining Association.

Outside the operation of local mines, Abraham Gesner (1797-1864), a physician in Parrsborough (now Parrsboro), was also actively studying the local geology and published his "Remarks on the Geology and Mineralogy of Nova Scotia" in 1836.[17] Soon after publication, Jackson and Alger made repeated appeals to Nova Scotian officials with claims Gesner had plagiarized their work.[18] Regardless, Gesner mentioned several influential sources (Jameson, Cleveland, Sternburg, Buckland and Cuvier) for "his" work, and went on to say: "But it was the task of Mr. Lyell, to collect the scattered fragments of Geological Science, and erect a beacon to guide the wandering student in the path of philosophical truth, and to solve those difficulties theoretical writers had thrown in the naturally obscure way."[19]

Some of the difficulties Charles Lyell had solved included the nature of the geological evidence attributed by some to the great deluge of Moses (diluvium). Aligning with a scriptural interpretation, in 1828 Jackson and Alger had noted large boulders on the Nova Scotia landscape they supposed were "transported hither by that great and sudden catastrophe, which has almost every where left such incontestable proofs of its violence."[20] In the final version of their report, Jackson and Alger referenced Rev. William Buckland's brief description of large granite boulders sitting on top of slate in Nova Scotia[21] as evidence in "support of the diluvial current" and noted that while they had not seen any "furrows or parallel scratches upon the surfaces of rocks" in Nova Scotia that "such may reasonably be expected in a country like this, where the boulders so fully attest the occurrence of that event".[22] With the publication of Charles Lyell's three volume treatise on the "*Principles of Geology*" from 1830-1834, he countered the Biblical interpretations of geology by popularizing James Hutton's theory of uniformitarianism, and postulated that the diluvial geology was the result of transport by floating ice rather than a great flood.

Charles Lyell (1797-1875), born to a wealthy Scottish family obtained an M.A. in classics from Oxford in 1822, had become a prominent geologist in Britain in the 1830's. Lyell had received the Royal Society Medal in 1836 and was the President of the London Geological Society in 1837. It was this recognition that resulted in Lyell's invitation to visit North America to deliver the Lowell Institute public lectures between 1841 and 1843, and 1852.[23] During Lyell's return trip to Britain in July of 1842 he decided to stop in Nova Scotia for a month to explore the region's geology.[24] It was during this visit to Nova Scotia that Lyell met many local Nova Scotian geologists, including Dr. Abraham Gesner, Dr. Ebenezer Harding and John William Dawson. Dawson, having begun his academic training in geology was then mentored by Lyell and supported by collaborations with local citizen physician-geologists.

John William Dawson (1820–1899)

J. W. Dawson was born in Pictou in 1820, spent his youth working in the printing shop run by his father, James Dawson, and established his strong interest in natural history during his early years of education at Pictou Academy

(1833-39).[25] As a student of Thomas McCulloch, Dawson was also encouraged to present a paper at the Pictou Literary Society titled "On the Structure of the Earth" when he was only 16 years old. Dawson pursued his interest in fossil and natural history, assisted in his interests with help from people like Dr. Abraham Gesner, and on the other shore of the Minas Basin, Isaac Chipman in Horton. Dawson then studied geology, taxidermy and geological thin sections at the University of Edinburgh from 1840 to 1841, before family financial challenges forced him to return to Nova Scotia.[26]

Edinburgh was significant for Dawson's education in geology and he returned again in 1847 to complete additional training on microscope methods. At this time Dawson also commissioned his "Map of Nova Scotia and Prince Edward Island," a lithograph created by W. Nichol & Co., Edinburgh, which was then printed in Nova Scotia by James Dawson in 1848 to accompany the first edition of his popular *Hand Book of Geography of Nova Scotia and Prince Edward Island*. The importance of this early work is demonstrated by the fact that the map and the "Hand Book" were displayed among the Nova Scotia exhibits at the 1851 Great Exhibition in London.[27]

Following the important visit of Charles Lyell, Dawson came into frequent contact with Ebenezer Harding, a doctor in Windsor: three letters over a ten-year period from Dr. Harding to Dawson in the Redpath Archives (transcribed by the author, Appendices 1-3 https://cstha-ahstc.ca/scientia-canadensis/tracking-the-fossil-footprints-appendices/) exemplify this correspondence. These letters highlight the importance of citizen-engaged science demonstrating how Harding provided Dawson specimens and shared field observations that contributed to Dawson's seminal work, *Acadian Geology* and its important geological map. In contrast to the government geology surveys that were carried out in New Brunswick by Gesner in 1838 and the establishment of the Geological Survey of Canada with William Logan in 1842,[28] the letters provide an example of the network of citizen geologists in the early history of geology in Nova Scotia that was critical for the development of local expertise that contributed to a growing international science.

Dr. Ebenezer Harding and Citizen Science

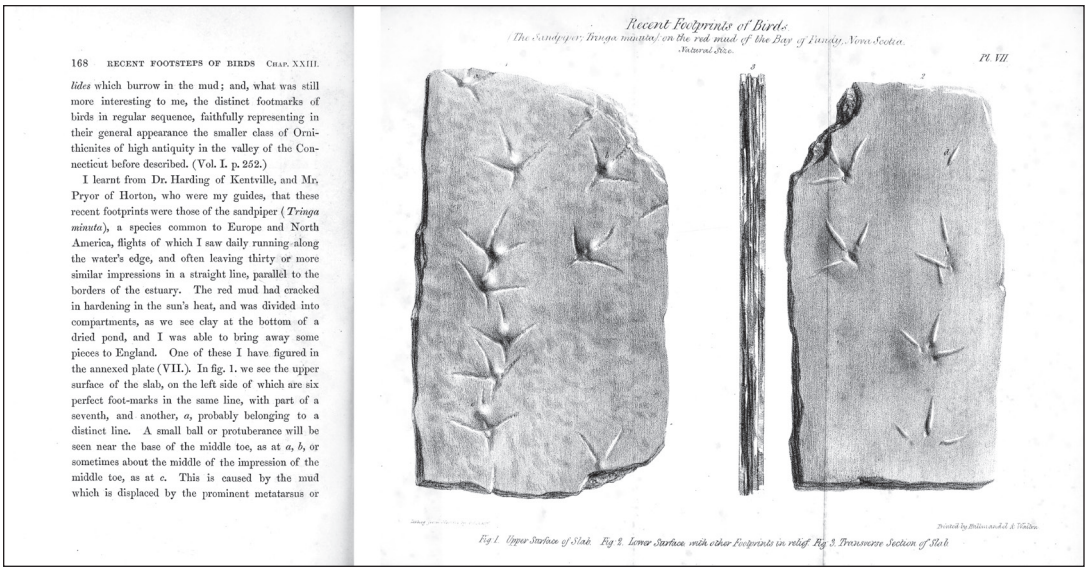
Throughout the history of geology in Nova Scotia, physician-geologists have pursued interests in natural sciences and made significant contributions to the science of geology.[29] Prominent examples include Dr. Abraham Gesner, a physician in Parrsboro from 1826 through 1836 who published many significant contributions;[30] Dr. William Webster, a physician in Kentville from 1830s to 1861; and, the subject of this article, Dr. Ebenezer F. Harding (**Figure 1**), the physician in Windsor from 1823 until 1860. Harding was born in Wolfville, Nova Scotia, on August 20, 1799, the son of Rev. Theodore S. Harding, a Baptist Minister in Wolfville for 60 years. Harding attended the Pictou Academy, established in 1811 by Thomas McCulloch. The Academy was formally recognized by the Nova Scotia Assembly in 1816, and by 1817 had 53 boys enrolled.[31] A

Figure 1. *Photograph portrait of Dr. Ebenezer Fitch Harding from Nova Scotia Archives (citation), and scan of original letter from Dr. Harding to J. W. Dawson, April 16, 1855. McGill University Archives, MG1022_ Acc2211-177_04-16-1855*

young Ebenezer Harding was one of these early students at Pictou Academy as had been John Dawson.

After graduating from the academy, Harding studied medicine, initially as apprentice with Dr. Anderson in Halifax and then with Doctor Robert Bayard in Kentville. Harding finished his training at the College of Physicians and Surgeons of New York, graduating in 1822.[32] Returning to Nova Scotia, Dr. Harding began practicing medicine in Kentville in 1823. Encouraged by Thomas Haliburton, Harding moved to Windsor in 1831 where he worked as a doctor and dentist, until his death in 1860. Dr. Harding was a highly engaged citizen; he served as a member of the Board of Directors of the Nova Scotia Baptist Education Society; as Clerk of the Peace for Supreme Court in Windsor; as Postal Clerk; and was a Founding Member of the Medical Society of Nova Scotia in 1854.[33]

Working as a country doctor, Harding also provided training to students, including Charles Tupper (1821-1915) who apprenticed with Dr. Harding in Windsor between 1839-1840 and then attended school in Edinburgh where he received a diploma from the Royal College of Surgeons of Edinburgh in April 1843.[34] Tupper wrote fondly of his memories of working with Harding. After completing his medical training in Edinburgh, Tupper returned to his home town of Amherst, Nova Scotia, and established his own practice as a medical doctor and dentist.[35] Tupper then entered politics in 1856 as provincial secretary at a critical period for the province and country, and this same year Tupper played a central role in Nova Scotia establishing its mineral rights previously held by the monopoly of the General Mining Association.[36] Charles Tupper's strong relationship with Dr. Harding, Tupper's time in Edinburgh and his role in obtaining the mineral rights, establish linkages between the local physician-geologists and the political spheres of the province during the establishment of the culture of geology in Nova Scotia.



168 RECENT FOOTSTEPS OF BIRDS CHAP. XXIII.

lides which burrow in the mud; and, what was still more interesting to me, the distinct footmarks of birds in regular sequence, faithfully representing in their general appearance the smaller class of Ornithichnites of high antiquity in the valley of the Connecticut before described. (Vol. I. p. 252.)

I learnt from Dr. Harding of Kentville, and Mr. Pryor of Horton, who were my guides, that these recent footprints were those of the sandpiper (*Tringa minuta*), a species common to Europe and North America, flights of which I saw daily running along the water's edge, and often leaving thirty or more similar impressions in a straight line, parallel to the borders of the estuary. The red mud had cracked in hardening in the sun's heat, and was divided into compartments, as we see clay at the bottom of a dried pond, and I was able to bring away some pieces to England. One of these I have figured in the annexed plate (VII.). In fig. 1. we see the upper surface of the slab, on the left side of which are six perfect foot-marks in the same line, with part of a seventh, and another, *a*, probably belonging to a distinct line. A small ball or protuberance will be seen near the base of the middle toe, as at *a*, *b*, or sometimes about the middle of the impression of the middle toe, as at *c*. This is caused by the mud which is displaced by the prominent metatarsus or

Recent Footprints of Birds.

PL. VII

Fig 1. Upper Surface of Slab. Fig 2. Lower Surface with other Footprints in relief. Fig 3. Transverse Section of Slab.

Figure 2. *Charles Lyell's "Travels in North America" page 168 mentions Dr. Harding and observation of the modern Sandpiper footprints, and fold-out Plate VII faced it displays a lithograph of both surfaces and sideview of a slab of dried Bay of Fundy mud. The depiction of the modern footprints preserved in a dried slab of Bay of Fundy mud represented a eureka moment for Lyell and Dr. Harding was present as a witness.*

Dr. Harding's interest in geology before 1842 is unknown, but as a physician-geologist, Harding travelled around Windsor and communicated regularly with Dawson about Albion Mines, Pictou. Harding also contributed significant fossil discoveries and assisted visiting geologists to better understand the complex geology of the area. It is unknown how they were introduced, but in 1842, Harding accompanied Charles Lyell along the shore of the Bay of Fundy during Lyell's visit to Nova Scotia, which Lyell noted, mentioning Harding by name, in his popular book *Travels to North America*. [37] Harding and Mr. John Pryor (a founding member of Acadia University) were with Lyell when he observed a sandpiper walking in the Bay of Fundy mud, leaving a distinct trackway in the soft-muddy sediment (**Figure 2**). This observation was significant as it provided him a modern analogue to explain the process of the development of fossil footprints that he'd seen elsewhere in Eastern North America. Interpreting geology through study of the present geological processes was a foundational concept for Lyell in the *Principles of Geology*.

Charles Lyell in Nova Scotia

On July 31, 1841, Charles Lyell briefly stopped into Halifax during his trip from England to Boston: "I landed here for six hours, with my wife, during which we had time to drive about the town, and see the museum, where I was shown a large fossil tree filled with sandstone, recently sent from strata containing coal in the interior. I resolved to examine these before returning to England, as they appeared by the description given to us, to afford the finest examples yet known in the world of petrified trees occurring in their natural or erect position." [38] The Halifax Mechanic's Institute was the only Museum

that Lyell and his wife could have visited during their afternoon in Halifax, although there is no mention of the esteemed visitor in the notes of the Institute for that year.

Lyell returned to Nova Scotia in July of 1842, but the summer of that year was a challenging economic situation in Nova Scotia. The Halifax Mechanics' Institute did not meet at all between May 11 and August 27, and the members spent the next several meetings planning lectures for the upcoming year and briefly considered a proposal to organize a bazaar.[39] Unfortunately, they had not recognized the opportunity to engage with Lyell during his 1842 visit. It was the physician-geologist Doctor Harding, son of a prominent Baptist Minister, and John Pryor, Professor of Queen's College who literally walked in the footsteps of Charles Lyell on the beach of the Bay of Fundy.

Doctor Harding was present to share in Lyell's moments of insight while walking along the shores of the Bay of Fundy, with the three letters from Harding to Dawson providing new information about Lyell's visit in 1842 and the publication of *Acadian Geology* in 1855. The historical documentation of these collaborations and travels provide insight into the regional community networks at the time.

Between 1830 and 1850, Windsor was an active and important transportation route between Nova Scotia and Saint John, New Brunswick. In 1833, the "Maid of the Mist" became the first steamer mail packet between Windsor and Saint John,[40] which decreased travel time between Halifax and Saint John to 24 hours. Compared to travelling by bumpy carriage rides along "the Great Roads" between Halifax, Truro, Amherst and Saint John, the Minas Basin was a more popular transportation route. With the government financially supporting a packet route, Dr. Harding also acted as a Postal Clerk at Windsor starting in 1835. He reported that "the Parrsborough Packet has made routine voyages between Windsor and Parrsborough as according to regulations of the Court of Sessions."[41] This role provided him the opportunity to observe features in geological materials from the region while inspecting items on the ships. It was on such a visit to the Windsor wharf that Dr. Harding likely came upon a slab of stone shipped from Parrsboro and noticed a trackway of fossil footprints.[42]

It is not surprising that Dr. Harding would examine geological material that had come from Parrsboro. The two communities were strongly tied through the shipping activity of the Minas Basin. The name of the basin is a secondary derivation of the English "Bason of Mines,"[43] translated from the original (1764) French name "Bassin des Mines,"[44] referring to the abundant coastal exposures of geological formations that were sources of copper and gypsum. Between 1830 and 1850, the shipping packets that travelled from Windsor through the Minas Basin provided an important linkage for trade (plaster, lumber, etc.) to Saint John, New Brunswick.[45] Parrsboro was often a stop along this route, and other smaller packets also travelled across the Bay of Fundy that provided additional routes. Abraham Gesner practiced medicine in Parrsboro from 1826 to 1836, and spent his free time roaming the coastal shores and riverbanks. The

region also attracted geologists from outside Nova Scotia. The period from 1852 through 1855 also saw a young Othniel Charles Marsh spending his summer vacations in the Minas Basin collecting minerals with his friend William Park. Marsh's trips are documented in his weekly diary, including a note that Marsh had stopped in to see Harding when in Windsor on his return to Andover in 1855. Marsh eventually published his summary of mineral collecting sites in 1863.[46]

In the 1840s, education institutions in and around Windsor began to support the study of geology and the emergence of a culture of geology. Both King's College, established in 1789, and Acadia University, founded in 1838 in nearby Wolfville, attracted scientists and created geology programs. King's College had earlier dedicated few resources to geology until it hired Edinburgh-trained Henry How to teach chemistry and natural history in 1854. How went on to collaborate with Dawson and made significant contributions to the mineralogy of Nova Scotia. At Acadia University, Isaac Chipman established a geology program, leading students out into the field to collect minerals before dying tragically on one such trip in the Minas Basin.[47]

The development of a collective culture in geology was also aided by other public institutions dedicated to disseminating knowledge. These institutions included natural history societies, such as the Pictou Literary and Scientific Society (1834-1855) established by Dawson's teacher and mentor Thomas McCulloch and Mechanic's Institutes.[48] Mechanics Institutes were first formed in Canada in the late 1820s s to provide instruction to workers, but catered more to the middle classes, inculcating an interest in science, including geology.[49] While Windsor was home to a Mechanic's Institute in 1842, it was the Halifax Mechanics Institute that advanced geology when it commissioned Titus Smith to conduct a summary of Nova Scotian geology and make a representative collection of rocks and minerals. The Institute published Smith's report in 1834, which was then republished in 1836 in the Magazine of Natural History.[50] This direct citizen-engagement in the early history of science in Nova Scotia provided a conduit for public adoption of new scientific worldviews, in particular Charles Lyell's views on geological time advanced in his *Principles of Geology*.

Letters of Geology

I became interested in Dr. Harding's history after studying a fossil footprint site in Parrsboro in 2015. Hoping to learn more about the sites where previous footprints had been found, I located Harding's three letters in Dawson's files at the McGill University Archives. The letters have now been transcribed (Appendices 1 to 3 https://cstha-ahstc.ca/scientia-canadensis/tracking-the-fossil-footprints-appendices/) and the information in the letters lead to the wider examination provided here. Although the letters did not contain new information about fossil footprint sites, they do provide a frame to consider the "collective" aspect of this critical time in Nova Scotia geology.

The letters demonstrate interactions between rural communities in the 1840s,

with Dr. Harding in Windsor and William Dawson located in Pictou. In 1845, Harding noted his letter would be carried by Thomas Randall, who happened to be travelling from Windsor to Albion Mines. The letter of 1847 was carried along with mineral and shell specimens by Rev. DeWolf. These were not regular postal routes, but rather Harding and Dawson relying on messages being delivered by those who were travelling between the two busy port towns. There was a period of road building between 1815 and 1850, providing increased overland transportation by horse-carriage, but the train between Windsor and Halifax did not begin until 1858.[51] The letter from Harding to Dawson written on April 16 (**Figure 1**) represents an early stage of postal history in Nova Scotia, as it includes stamps in Windsor (April 17), Halifax (April 18) and Pictou (April 19).

The first letter (July 28, 1845) was sent three years after the visit by Charles Lyell. In it Dr. Harding mentions the previous receipt of a letter from Dawson, and there being some delay in Harding's reply. Harding's letter also mentions a recent missed opportunity for the two to meet and "explore sites of interest to the geologist." Harding had gone to meet Dawson at "Mr. Brass's" (Hotel), but Dawson had already left.[52]

This first letter also mentions Harding's interest in shells of Nova Scotia, and he requests representative samples that Dawson might be able to spare. This is a topic that Harding returns to in all three letters, so represents a strong personal interest. Dr. Harding appears to have been establishing a representative shell collection and seeking information lists and extra specimens that Dawson might provide. Unfortunately, any shell collection that Harding established remains unknown. It would not be until 1859 that John. R. Willis (1825-1876), Principal of the National School, Halifax, establish a representative collection of shells in Nova Scotia.[53]

In the 1845 letter, Dr. Harding also provides a report of the investigations he had recently made walking up the banks of Halfway River and while visiting a site at Snides Mill. The details in Dr. Harding's letter provide geological observations of fossils and rock types, proposing correlation of strata between the two sites and noting the difference from gypsum deposits along the Avon. Charles Lyell also mentions visiting Snides Mill during his trip of 1842, stating: "I also found, in going southwards from Windsor to a small tributary of the Avon, on which is situated Snides Mill, that the gypsiferous series incloses, before its junction with the older rocks, course sandstones with a seam of impure coal two inches thick, also clay-iron-stone, and shales with *Lepidodendron elegans*, but no strata resembling the productive coal measures."[54]

Snides Mill was not found directly labelled or mentioned in any other historical maps or surveys. However, responding to my request for information about a historic mill located south of Windsor on a tributary of the Avon River, Jonathan Fowler shared a detail of a historic survey map produced in 1836 by Titus Smith.[55] An earlier map of the same area in 1818 by Wolford,[56] identifies the nearby "Burdain's Inn" but does not show a building at the site where a dam and "mill pond" shown in Smith's map in 1836 (**Figure 3**). The location

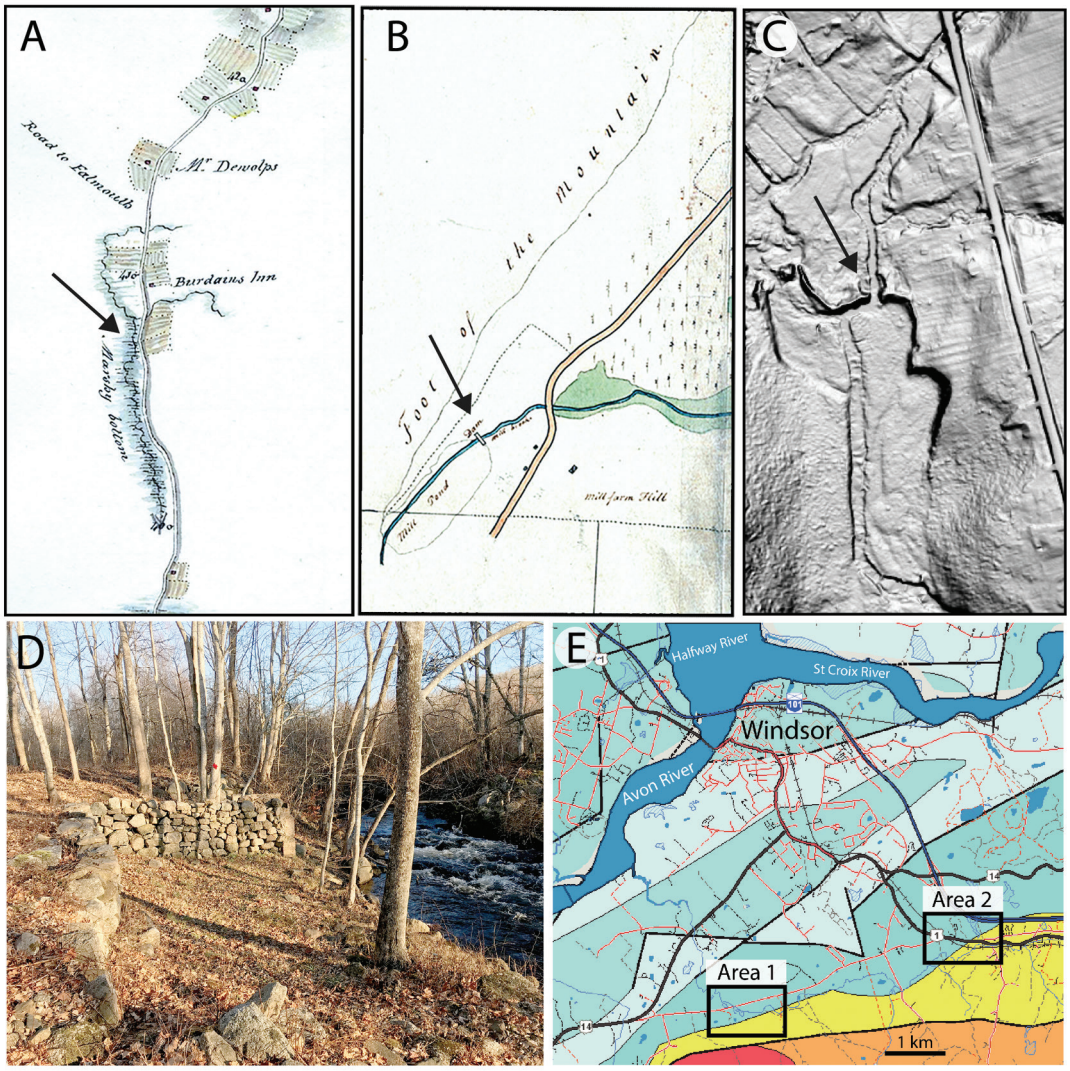


Figure 3. *The likely location of Snides Mill (arrows) mentioned by Lyell and described in Dr. Harding's letter (1847); shown on maps from, A - Wolford (1818), B) - Titus Smith Survey (1836), and C) modern hill-shade LiDAR that shows the foundation of the old mill that is still at the site (D). The modern geology map (E) shows the location of Snides Mill (Area 1) and the location "2 or 3 miles to the southern on the old road" (Area 2) that both have contact between the Horton Group (yellow) and Windsor Group (blue).*

of this unnamed mill corresponds with a modern hill-shade map that shows a foundation of a dam/mill at the end of the pond. This was later confirmed during a recent visit to the site where an old turbine wheel had been dredged from the river by a previous property owner.

Evidence to support this site as the location of "Snides Mill" is that the description of geology offered by Harding aligns very well with the geological details depicted in modern geology maps of the area (**Figure 3**). The geology at Snides Mill represents a contact between the Carboniferous Windsor Group limestones and gypsum deposits and the older Horton Group sandstones and shales. Another similar contact was described by Harding in the 1845 letter as "2 or

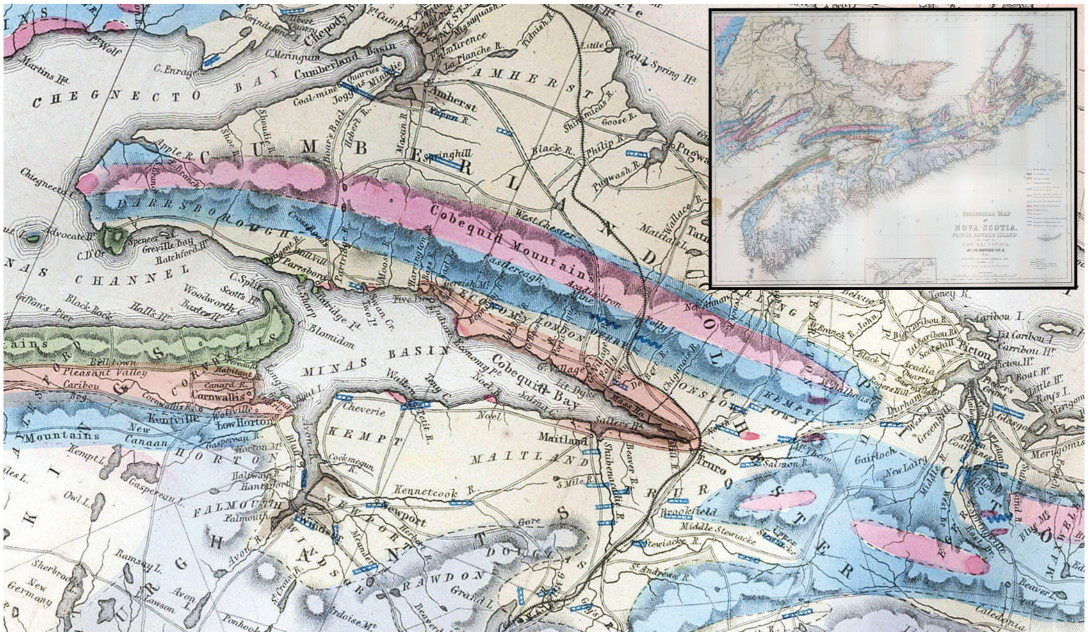


Figure 4. *Detail of Minas Basin and Pictou areas from Dawson Geology Map of Nova Scotia and PEI, 1855. The information Dr. Harding provided to Dawson helped to inform the geology details mapped in the Windsor area.*

3 miles to the southern on the old road, sandstones, quartzose grindstone and slates prevail". These types of observations are what informed Dawson's understanding of the spatial relationship of the beds in the area and informed the boundaries of the rock types he would eventually publish in his 1855 map (**Figure 4**).

Dawson returned to Windsor area to make additional geological studies after receiving Dr. Harding's 1845 letter. An image of "Part of Cape Blomidon, 1846" was drawn directly by Dawson, and includes two men in top hats seated in discussion at the base of the cliff. The drawing would have been done on-site by direct observation, and is evidence that Dawson was in the area (perhaps with Doctor Harding) in 1846 in between the two letters. Dawson's original drawings were then translated for printing by the intaglio artist William H. Lizars, a prominent printmaker in Edinburgh. The drawing demonstrates the importance of direct observation and drawing as part of Dawson's research and geology publications.

The second letter from Dr. Harding to William Dawson in August 1847, begins by noting specimens of the fossil shell *Orthoceras* that Harding is sending to Dawson. These specimens relate to the detailed descriptions that Dawson later provided in *Acadian Geology*. Harding ended the 1847 letter recognizing Dawson had sent a list of shells, and Harding listed names of some that he was particularly interested in obtaining. Several of the taxa listed by Harding are found in the list of "Molloscous Animals" that Dawson included in the *Hand Book of the Geography and Natural History of the Province of Nova Scotia* that he published in 1848. It was for this publication that Dawson had commissioned

his map of Nova Scotia and PEI that became the base map he also used for the geological map published in 1855. The list Dawson provided may also have related to fossil shells of potential interest to Harding, and was likely the list printed in the second volume of Lyell's *Travels in North America* published in 1845. The fossils listed by Lyell are significant for the history of paleontology in Nova Scotia and several of the specimens are located at the Natural History Museum, London.[57] These fossil specimens were collected by Lyell during his trip in 1842 and perhaps with Dr. Harding at his side.

The third letter from Harding to Dawson in August of 1855, mentions Edinburgh in terms of Dawson's interest in the opening as Professor of Natural History. Edinburgh would have been an exciting opportunity for Dawson's career, and demonstrates the linkages that had been established between Edinburgh and Nova Scotia geology through Dawson and others. Edinburgh connections included Dawson's time studying geology in 1840-1841 and again in 1847, and the production of the lithograph of Dawson's Map of NS and PEI. Dr. Harding's student, Charles Tupper, had studied (medicine) at Edinburgh during Dawson's time there, and his later political influence in Nova Scotia is of interest to the culture of geology during this period. It's also interesting to consider, Rev. David Honeyman (1817-1899), the first curator of the Nova Scotia Museum, grew up in the Dundee area and then preached in Glasgow and Edinburgh in 1841. One might imagine a public geology talk in Edinburgh in 1841, where Dawson, Tupper, and Honeyman could have all been in the audience together.[58]

Another important connection between Edinburgh and Nova Scotia geology was Doctor William Webster, who attended medical school at University of Edinburgh (c. 1818) before returning to Kentville to practice medicine. Webster was another active physician-geologist in Nova Scotia, who sent letters and specimens of modern rain marks and footprints to Lyell in 1847.[59] These letters and specimens Webster sent to Lyell were likely of a similar nature to those between Harding and Dawson. It is of interest to determine if similar letters from Webster to Lyell can be located among Lyell's archived materials. New work is being done to digitize Lyell's notebooks, recently purchased by the University of Edinburgh, which will provide valuable insights into the other people Lyell met and observations he made during his time in Nova Scotia.

Dr. Harding mentions the exciting opportunity that Edinburgh provided for Dawson's career, but also laments the potential loss for Nova Scotian science. It turned out that Dawson was not chosen to fill the position, but he still left Nova Scotia to take on his new role as Principal at McGill. The third letter from Doctor Harding is significant in his reference to the upcoming publication of Dawson's book (*Acadian Geology*), and an offer to help distribute copies among his fellow citizens with an interest in geology. The letter and offer represent a direct connection between the "collective" work of Dawson's book and Dr. Harding's interest in promoting it locally. It is unclear if the Windsor Mechanics' Institute was still active in 1855, but the members listed in 1842 would likely be included in those who Dr. Harding would have sold copies to.

The three letters that Dr. Harding wrote to Dawson provide insights into the collaborative relationship that existed between the two of them. The initial publication of *Acadian Geology* (1855) and a supplemental chapter in 1860 only briefly mention Dr. Harding in terms of the fossil footprints that he had found. Harding unfortunately died in 1860 before seeing Dawson's second revised edition (1868) that included expanded content and recognition of contributions from several physician-geologists, including Dr. Harding. Dawson recognized Harding's contributions through honorific species names, including the footprints identified as *Hylopus hardingi*, an invertebrate shell *Macrodon hardingi (*now *Parralelodon hardingi)* found in the Windsor area, and a fossil fish from Horton Bluff, *Rhizodus hardingi*. The naming of species in honour of Harding's contributions was formal recognition by Dawson of the collective culture that had been essential to his work as a geologist. Of all the specimens that Dr. Harding provided to Dawson, the footprints *Hylopus hardingi* are perhaps the most scientifically important, and also demonstrate how the study of this particular fossil was a collaborative process.

Hylopus hardingi

Unfortunately, the letters to Dawson do not mention the footprints Dr Harding had found among the shipment of stone from Parrsboro. However, Harding likely shared the information in a similar letter, relaying the information as part of their collective collaboration. Dawson described the story of Dr. Harding finding, in 1850, "Tracks of Reptilian animals, discovered at… Parrsboro" in his descriptions of the specimens.[60]

> In a bed near Partridge Island, Dr. Harding of Windsor found, several years since, a fine series of footprints, probably of a small reptilian animal.[61]

> Shortly afterward, Dr. Harding, of Windsor, when examining a cargo of sandstone which had been landed at that place from Parrsboro', found on one of the slabs a very distinct series of footprints each with four toes, and a trace of the fifth. Dr. Harding's specimen is now in the museum of King's College, Windsor. Its impressions are more distinct, but not very different otherwise from those above described as found at Horton Bluff. The rocks at that place are probably of nearly the same age with those of Parrsboro. I afterward examined the place from which this slab had been quarried, and satisfied myself that the beds are Carboniferous, and probably Lower Carboniferous. They were ripple-marked and sun-cracked, and I thought I could detect trifid footprints, though more obscure than those in Dr. Harding's slab. Similar footprints are also stated to have been found by Dr. Gesner, at Parrsboro.[62]

Lyell also mentioned Dr. Harding's discovery in his *Elements of Geology*.

> Footprints of two reptiles of different sizes had previously been observed by Dr. Harding and Dr. Gesner on ripple-marked flags of the lower coal-measures in Nova Scotia, evidently made by quadrupeds walking on the ancient beach, or out of the water, just as the recent Menopoma is sometimes observed to do.[63]

Although often overlooked in the history of science, a fossil trackway found by William Logan in 1841 at Horton Bluff, near Windsor, noted briefly in the Proceedings of the Geological Society of London in 1842 – was the first evidence

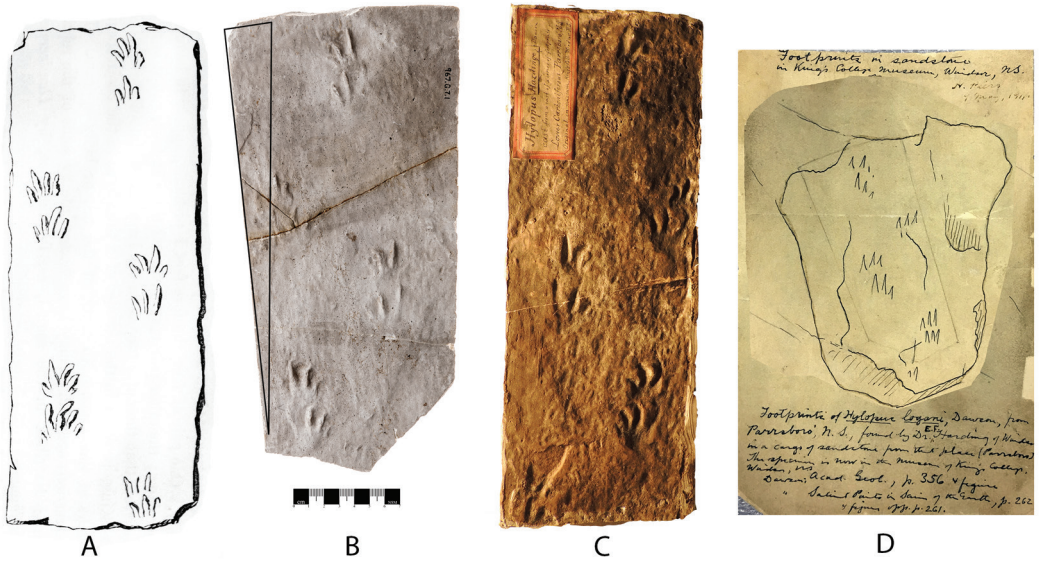


Figure 5. *Depictions and casts of Hylopus hardingi fossil footprint specimen: A – the first published figure of the specimen by Dawson in 1868; B - a plaster cast (mold) of the original specimen in the Geology Collections of the Nova Scotia Museum, NSM967GF7.1; C – a plaster cast at New Brunswick Museum, NBMG 3060; and D – a curatorial sketch of the original fossil specimen by Harry Piers (Curator of the NSM) seen at King's College on May 9, 1911. The NSM plaster cast is broken and missing an area on the bottom edge but it does record a small area (triangle) that is not recorded by the NBM plaster cast.*

of terrestrial (land, walking) animals existing in the Carboniferous.[64] Much later, in 1882 when Dawson described and named these tracks he eventually named them in Logan's honour, *Hylopus logani*. Following the discovery of footprints found by Logan in 1841, and Dr. Harding in 1850, Dawson and Lyell in 1852 then made the important discovery of terrestrial animals preserved in the tree stumps at Joggins.[65] When Dawson published his description and illustration of the footprints Dr. Harding had found he named them in his honour as *Hylopus hardingi* (**Figure 5a**).

Unfortunately, the location of the original rock slab with the fossil trackway of *H. hardingi* remains unknown, and the fossil was likely lost during the fire in the Science Building at Kings College in 1920. This is significant in that *H. hardingi* had become the type species for the ichnogenera. A plaster cast (mold) of the trackway (**Figure 5b**) remains in the geology collection of the Nova Scotia Museum, and a second plaster cast (**Figure 5c**) is at the New Brunswick Museum. It is interesting to think that these fossil footprints were reproduced from plaster made from the underlying gypsum deposits in Windsor; industry and artisan skills applied to science.

In a review of fossil footprints published in 1904,[66] George F. Matthew (1837-1923) provided a new illustration of the cast of *H. hardingi* trackway and noted that Dawson's diagram from 1863 (**Figure 5a**) had been developed from a rubbing of a cast provided by Henry How (1828-1879) who was a prominent Professor of Natural History and Chemistry at King's College from 1854 until he

died in 1879.[67] In 1904, Matthew also noted that Professor George T. Kennedy of King's College, had recently examined the original in the museum of the College. The original specimen was last seen at King's College Museum by Harry Piers on May 9, 1911, when he created a curatorial sketch of the specimen (**Figure 5d**). In February 1920, a large fire destroyed a portion of the campus of King's College – eventually leading to the campus being relocated from Windsor to Halifax and became Dalhousie University King's College. Dr. Harding's original fossil footprints appear to have been lost in the fire.

The history of *Hylopus hardingi* remains of importance for taxonomic ichnology, but also demonstrates how the collected specimen was then studied through plaster casts and documented with direct rubbing and illustrations. The collaboration that existed between Dr. Harding and J. W. Dawson can be traced through these specimens, the letters they exchanged, and the relationships that developed through collections that became stored at museums in local universities like King's College.

Conclusion

The letters from Dr. Harding to William Dawson provide insights into the initial collection of specimens and sharing of knowledge at an important phase of the culture of geology in Nova Scotia. The letters demonstrate Dr. Harding's primary interest in shell collecting, and include inventories of fossil specimens and descriptions of geology sites visited. The letters also refer to other people involved in the community of geology, providing future opportunities to expand the understanding of citizen science in this early phase of geology.

In referring to Dawson's opportunity for a Professorship in Edinburgh, the 1855 letter highlights the strong relationship that had been established between Nova Scotia and Edinburgh geological science. Dr. Harding also established an Edinburgh linkage through Charles Tupper who was at Edinburgh in overlapping years with Dawson. Professor Henry How was among the Edinburgh scene as well just before arriving in Nova Scotia, and the creation of Dawson's map in Edinburgh in 1847 that accompanied the publication of Dawson's "Hand Book" the following year, provided the foundation on which Dawson could depict his summarization of Nova Scotia geology.

Recognition of these important relationships between Edinburgh and Nova Scotia geology provide opportunities for future projects to study and add valuable information to historical collections and contributions to the history of science. It will be of value to examine the ongoing digitization of Charles Lyell's journals at the University of Edinburgh, particularly the journals from 1842, as well as comparing similar journals of Dawson at the McGill Archive. Future work is also being planned to examine the samples of rain drop prints and footprints in Bay of Fundy mud that Dr. Webster sent to Lyell, which will also expand on the scope of connections between Nova Scotia, Edinburgh, and the history of geology.

The letters mention historic sites of geological importance such as Snides Mill and Halfway River, areas where preliminary geological observations were made. By tracing descriptions of these sites, and references to local accommodations (Brass' Hotel, Burdain's Inn), the social aspects of travel and accommodations during Lyell's visits and Dawson's work making geological observations is shown. These hand-written letters—describing travel, observation of geology sites, and exchange of specimens and information—demonstrate the collective aspects, of collaboration and collections, in early geological investigations in Nova Scotia.

The development of the visual language of geology in Nova Scotia could also be explored in future research. The absence of any sketches, drawings, or maps in Dr. Harding's letters, strongly contrasts with Dawson's extensive use of images in the first edition of *Acadian Geology*. With Dawson's experience in his father's printshop, he had established strong visual communication skills. Dawson communicated geological observations with visual depictions of specimens, developed geology maps, and visual reconstructions of ancient ecological landscapes. Lyell's publication of *Travels in North America* inspired interest in Nova Scotia geology and included important lithographs depicting important mud samples observed by Dr. Harding and Lyell on his trips to Nova Scotia. The development of "map reading" in Nova Scotia is demonstrated by comparing the early hand-drawn survey maps of Windsor area, the earliest geological map of Jackson and Alger in 1833, the refinements made by Dawson in 1855, can be contrasted with the advanced digital media now available to examine Nova Scotia geology. Dawson's base map, originally produced in Edinburgh to accompany his *Hand Book* also provides interesting historical linkages with education and printing innovations of the time. Depiction of geological landscapes, like the Cliffs at Blomidon in 1846, demonstrate Dawson's skill and use of observation drawings, later translated into a intaglio images in Edinburgh.

Within the context of visual language of geology, it is also interesting to consider the important history of plaster casts of fossils used as primary scientific references. The early plaster casts produced at King's College acted as three-dimensional depictions of the rock surface, which were used to produce tracings that were then published as woodcut images. The surviving plaster casts from the 1860s represent very early examples of fossil reproduction in North America. It is also interesting to recognize that the plaster used to make the casts was gypsum harvested from the same area where the Carboniferous fossil footprints were found.

By tracking down the details of the *Hylopus hardingi,* we find the history of modern and Carboniferous footprints from Nova Scotia that directly influenced the history of geology. Lyell's observation of modern bird tracks in the Bay of Fundy mud during his visit to Nova Scotia in 1842 had profound implications for his interpretation of fossil footprints. The fossil footprints found by Harding and others were traces from an ancient landscape, and it was Lyell seeing birds walking in the Bay of Fundy mud that provided the modern analogue to explain this geological phenomenon.

The historical context surrounding the first edition of Acadian Geology remains of value for the diffusion of geological concepts in Nova Scotia. Dawson's Acadian Geology was the result of 'collective' work done by Dawson and other Nova Scotians interested in documenting the important geology of Nova Scotia. Dawson was an articulate writer and scientist who effectively used visual images to convey complex geological details. The publication of Acadian Geology in 1855 remains a milestone in Nova Scotia science and continues to offer new insights when details are explored with modern tools and resources.

Tim Fedak is the Curator of Geology with the Nova Scotia Museum, and Adjunct Professor (Graduate Studies) at Dalhousie University. His research includes description and study of vertebrate fossils, and the history of geoscience of Nova Scotia including a project documenting the history of Rev. David Honeyman (#FindingHoneyman).

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