FROM FIELD TO FACT: WILLIAM E. LOGAN AND THE GEOLOGICAL SURVEY OF CANADA

by

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ABSTRACT

This dissertation reexamines William E. Logan's pioneering geological survey of the colonial province of Canada, 1842-1869, inspired by new historical perspectives on science, geography, exploration, cartography, gender, the body, and state formation. I begin with the rapid development of geological surveying and mapping in 1830s Britain, and locate Logan in two key worlds: the gentlemanly scientific circles of metropolitan London and the coal fields of industrial South Wales.

The second section addresses the problem of fieldwork in an unfamiliar environment, examining Logan's importation and adaptation of British scientific practices to his explorations of the Gaspé peninsula in the early 1840s. Here I analyze the physical and sensory experiences of the surveyor and his white and Native assistants as they struggled to measure and classify colonial territory. I interpret Logan's exploration narratives – his personal field diaries – to show how his British-Canadian field experience shaped his masculine approach to geological surveying. Equally importantly, Logan's personal example created a distinct and enduring field geologist identity in the culture of Canadian science.

The last chapters turn to the transformation of field experience into facts, through the mediums of industrial exhibitions, museum displays, printed reports, and geological maps. This shift of frame, linked to the previous theme by the central role of Logan himself, addresses the question of how knowledge circulates from the small, locally-specific spaces in which it is produced to the broader realm of public discourse. Thus, visitors to London and Paris exhibitions, or to the geological museum in Montreal, could examine carefully-labelled fossil and mineral specimens while viewing a detailed, colour-coded map laying out the subterranean potential of Canadian territory.

So deployed, these geological facts also had economic and political implications: Logan's industrially-arranged mineral collections reinforced imperial ideas about colonial development, while his testimony on the economic potential of northern regions helped to support agricultural settlement plans, contributing to the expansion of the state into Native-populated areas. Finally and most generally, Logan's geology led to a new conception of Canadian geography in terms of "Laurentian" rocks, later known as the Canadian Shield.

LIST OF ABBREVIATIONS USED

BAAS	British Association for the Advancement of Science
BGS	British Geological Survey (Archives), Keyworth, Nottinghamshire
BP/MUL	Robert Bell Papers, Special Collections, McGill University Library
CIHM	Canadian Institute for Historical Microreproductions [fiche #]
DBP	H. T. De la Beche Papers, National Museum of Wales, Cardiff
DCB	*Dictionary of Canadian Biography*, www.biographi.ca
ESIC	Earth Sciences Information Centre, Natural Resources Canada, Ottawa
GSC	Geological Survey of Canada
ICST	Archives, Imperial College of Science and Technology, London
JLA	*Journals of the Legislative Assembly of the Province of Canada*
LAC	Library and Archives Canada, Ottawa
LP/MUA	William Logan Papers, McGill University Archives, Montreal
NLW	National Library of Wales, Aberystwyth
ODNB	*Oxford Dictionary of National Biography*
PGSL	*Proceedings of the Geological Society of London*
PRO	National Archives (Public Record Office), Kew, London, U.K.
RISW	Royal Institution of South Wales papers, Swansea Museum, Swansea
RP 18xx	Geological Survey of Canada, *Report of Progress for the Year 18xx* (See list in Bibliography for details.)
SC	"Report of the Select Committee appointed to report upon the best means of making public the valuable information already obtained by the Geological Survey, and completing it at an early stage upon an uniform system," JLA 1854-5, Appendix L.
TPL	Baldwin Room, Toronto Reference Library, Toronto Public Library

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For professional guidance and assistance, I have to single out above all my supervisor, Eric Mills. Also invaluable has been the support, at various times along the way, of Canadian historians and historians of geology alike, including (but not at all limited to) Michelle Aldrich, Michael Cross, Rob-Roy Douglas, Greg Good, Ernie Hamm, Elsbeth Heaman, Chris Kitzan, Debra Lindsay, Paul Lucier, Gerry Middleton, Michael Rygel, Charles Smith, David Spanagel, David Sutherland, Peter von Bitter, Leonard Wilson, and in particular my vigilant and incisive external examiner, Suzanne Zeller. I also have to thank especially my committee members, Bertrum MacDonald, Gordon McOuat, and Shirley Tillotson, who have consistently taken an active interest in my academic well-being over the years.

If not for the work of librarians and archivists, historical research would be impossible. In the course of this project, I accumulated many debts of gratitude, in particular to Barb Cloutier of Natural Resources Canada (Earth Sciences Information Centre); Graham McKenna of the British Geological Survey; Tom Sharpe of the National Museum of Wales; as well as to the staffs of the British Library; Edinburgh University Library; Library and Archives Canada; McGill University Archives; the Institute of Commonwealth Studies and the Institute of Historical Research at the University of London; the National Library of Wales; the Oxford University Museum of Natural History; Rutgers University Libraries; the Swansea Museum; and my sentimental favourite, the U.K. Public Record Office, Kew.

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This dissertation is dedicated to my family, to my parents, to my partner Aki, and last, but not least, to our son Jamie.

But now I hear the orchestra begin to swell and so will leave off here, before being ushered forcibly from the stage.

Ottawa, March 2007

CHAPTER 1

Introduction

> I came to a place in the course of my scramble, for the rocks were very rough & uneven, up & down in all directions, where I found myself stopped by the water; and as it is very tedious & a great expense of time to clamber up the cliff, even after finding a place where it is practicable, & force your way through the tangled wood on its summit, I determined to wade. First I tried with my boots & stockings off merely, but that would not do, so I took off my trousers & drawers, & strapping these, & boots & stockings on my back, I passed over the difficulty. Not knowing however, how many more of them I might meet with, I determined to continue on in my altered costume, & so I did for upward of half a mile, overcoming 2 more water points.[1]

1.1 Rereading the Rocks

Why write about William Edmond Logan? Although Sir William (1798-1875) was probably the best-known and most important scientist in nineteenth-century Canada, this fact has meant that he has also received at least his fair share of attention in the relatively

[1] W. Logan, 27 August, 1843 Gaspé Journal, NLW. Editorial note: punctuation and capitalization have occasionally been modernized for clarity in quotations throughout this dissertation, but original spelling has been retained. An author's interlineations and cancellations have been indicated only when relevant to the argument being made.

small body of literature on the history of Canadian science. His unreservedly successful career as the founder and first director of the Geological Survey of Canada, his early years in Britain, his contributions to the theory of coal formation, his gruelling expeditions in the Canadian wilderness, his all-consuming devotion to the cause of useful national science, and his eventual knighthood all find their place in many a reference book.[2] If any mid-nineteenth-century Canadian scientist can be said to be well-known, it is he.[3]

Nevertheless, this dissertation proposes to broach the subject of Logan anew, informed by the historiographical developments (perhaps revolutions) of the last twenty years – for this is how it has been since the last major study of Logan appeared, Suzanne Zeller's *Inventing Canada* (1987).[4] Certainly, Zeller's work, along with Morris Zaslow's massive *Reading the rocks* (1975) and Bernard J. Harrington's original *Life of Sir William E. Logan* (1883), will continue to form the basis of all future studies of Logan and the early years of Geological Survey of Canada (GSC).[5] That said, the history of

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[2] Most recently, B. Shipley, "William Edmond Logan," in B. Lightman, ed., *Dictionary of nineteenth-century British scientists* (Bristol: Thoemmes Press, 2004), vol. 3: 1255-1259. Full references are given to published works on their first citation in each chapter, followed by an "author, short title" reference in any subsequent notes in that chapter.

[3] In autumn 2000, then-Prime Minister Jean Chretien's proposal to rename Yukon's Mount Logan after recently-deceased former Prime Minister Pierre Elliott Trudeau met with a great public outcry and was soon dropped. For a popular treatment of Logan's Canadian career, see B. Shipley, "Rough science in the bush," *The Beaver* 82.1 (February/March 2002): 8-15.

[4] S. Zeller, *Inventing Canada: early Victorian science and the idea of a transcontinental nation* (Toronto: University of Toronto Press, 1987); for updates and additional context, see the exhaustively-researched overview, S. Zeller, "The colonial world as a geological metaphor: strata(gems) of empire in Victorian Canada," in R. MacLeod, ed., *Nature and empire: science and the colonial enterprise*, *Osiris* (2nd series) 15 (2000), 85-107.

[5] M. Zaslow, *Reading the rocks: the story of the Geological Survey of Canada 1842-1972* (Toronto and Ottawa: Macmillan / Department of Energy, Mines and Resources Canada, 1975); B. Harrington, *Life of Sir William E. Logan, Kt., LL.D., F.R.S., F.G.S., &c., first*

science as a discipline has changed enormously since the mid-1980s, not to mention the remarkable growth in complementary fields large and small, such as cultural history, the histories of exploration and cartography, the history of imperialism, the historiography of museums and exhibitions, the history of print culture, the history of the senses, environmental history, the history of gender, particularly masculinity, the history of native peoples in Canada, and the study of colonial state formation – all of which bear on the topic at hand. Exactly because Logan was so important to pre-Confederation Canadian science, his geological career deserves and demands to be re-examined from a fresh perspective. To appropriate Zaslow's phrase, it is well past time to "reread" the rocks.

The present dissertation seeks, of course, to improve our understanding of what exactly Logan accomplished, how, and what these accomplishments signified, but it hopes to do so in large part by building on and nuancing existing histories. It is not revisionist in the sense of proposing new answers to traditional questions (on the institutional and political history of the Survey, very aptly treated by Zaslow and by Zeller),[6] or indeed in questioning or apologizing for the special character of Logan's role in history – for better or for worse, there is simply no escaping the fact that any study of Logan is necessarily going to be a study of a "heroic" white male scientist. Instead, this

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director of the Geological Survey of Canada: compiled chiefly from his letters, journals and reports (Montreal: Dawson Brothers, 1883). A quick synopsis is C. Vodden, *No stone unturned: the first 150 years of the Geological Survey of Canada* (Ottawa: [Energy, Mines and Resources Canada], 1992). One should also acknowledge here the work of geologist Gordon Winder, which pioneered modern Logan studies, most notably with his C. G. Winder, "Logan and South Wales," *Proceedings of the Geological Association of Canada* 16 (1965): 103-124.

[6] In truth, the depth of research and detail present in both Zaslow, *Reading the rocks*, and Zeller, *Inventing Canada*, is so great as to remove any temptation to replough the ground that they have already made so fertile.

dissertation hopes to provide a new understanding of Logan by posing new questions – on subjects such as masculinity, and the creation of historical memory, for example – inspired by a wide range of critical and theoretical perspectives. It is also not, however, an explicitly theoretical work *per se*, in that it endeavours neither to establish nor to evaluate nor to exemplify a single model of (for example) how scientific knowledge is produced, or of how state power is exercised. Rather, it is ecumenical, seeking to generate as much light as possible by approaching the question from many angles.

The history of Canadian science has too often (in fact, almost always) been consigned to a doubly marginal status within the historical profession, failing to register substantially in the general literature on the history of science or of Canada, and hence one of this dissertation's further aims is to demonstrate that this need not be the case. According to an extreme and exaggerated view, Logan's geological surveying might be dismissed as routine fact-gathering in the farther reaches of a relatively unproblematic and therefore uninteresting colony. I intend to show instead that, viewed through a series of lenses borrowed from other literatures (enumerated above), the topic emerges as a fascinating example of the place of field experience in the creation of geological knowledge, and the ways in which that knowledge was made available to public audiences. Such an approach promises to deepen our appreciation of Canadian history and the history of geology alike. While specific historiographical discussion can be found at appropriate points throughout the following chapters, the purpose of this Introduction is to review some of the central perspectives that inform my analysis throughout (in suggesting questions to ask and approaches to consider), and in general to show how my project is situated with respect to the classic and contemporary (1990s-

2006) historical literature. In particular, the comments that follow focus on the contexts of the core keywords "geological survey," "Canada," and "William Logan." The final part of the Introduction then goes on to provide overviews of the source material and of the chapter-level structure of the text.

Anyone initiating a research project in the history of geological surveying faces a double-edged reality. Never having approached the amplitude of other sub-disciplines in the history of science (such as the history of physics or the history of biology, each of which contains numerous sub-fields larger than the history of all earth sciences combined), the history of geology has risked being further left behind in the last two decades years as a result of revolutions in the historiography of science generally.[7] Thus, the prospective historian of geology ventures out into a more or less wide-open field, but also one that is populated by relatively few landmarks. In 1985, Mott Greene called upon historians of science to "awaken from their dogmatic slumbers and see the history of geology as an area with broad implications for the study of science generally," and yet in 1999 Paul Lucier had to repeat this sentiment in pleading for recognition of geology's importance as an applied science, in order to remedy the fact that nineteenth-century North American geology, "the pre-eminent science of the time, remains largely unexplored."[8] Recently, however, the field has shown signs of being ripe for a change. After a fruitful burst of attention in the mid-1980s to early 1990s to the role of

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[7] For a recent review, see D. Oldroyd, "The earth sciences," in D. Cahan, ed., *From natural philosophy to the sciences: writing the history of nineteenth-century science* (Chicago: University of Chicago Press, 2003), 88-128. A rare exception would be the chapter on dolomite in I. Hacking, *The social construction of what?* (Cambridge, MA: Harvard University Press, 1999). See also D. Oldroyd, *Thinking about the earth: a history of ideas in geology* (Cambridge, MA: Harvard University Press, 1996).
[8] M. Greene, "History of geology," *Osiris* (2nd series) 1 (1985): 97-116, p. 97; P. Lucier, "A plea for applied geology," *History of Science* 32 (1999): 283-318, p. 285.

controversies in geology,[9] followed by a thematic flowering which saw the history of nineteenth-century geology expand into the history of twentieth-century earth sciences – neither of which, however, brought historical studies of geological *surveys* (as such) out of the domain of lists of names and dates – the current turns in the historiography of science toward geography, and toward field science in its own right, along with the rise of the discipline of environmental history, together serve to create openings into which a geological survey might at last be seen as a significant and even interesting species of scientific endeavour.

Indeed, the very category "geological survey" remains under-analyzed and under-theorized in the literature to date. It is not in the least the case that all such surveys were the same, or even similar, even when the analysis is restricted to the Anglo-North American context. Existing histories of geological surveying are generally factual, narrative, institutional studies – valuable resources, to be sure, but ones which intrinsically take for granted the (apparently self-evident) nature and importance of their subjects.[10] In order to answer the questions of what differentiated surveying from other

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[9] The classic studies that set out the history of British stratigraphy are M. Rudwick, *The great Devonian controversy* (Chicago: University of Chicago Press, 1985), J. Secord, *Controversy in Victorian geology* (Princeton, NJ: Princeton University Press, 1986), and D. Oldroyd, *The Highlands controversy* (Chicago: University of Chicago Press, 1990). In general, see also the discipline's journal, *Earth Sciences History*. My comments apply mainly to the history of geology in Britain and North America.

[10] A significant exception is G. Herries Davies, *Sheets of many colours* (Dublin: Royal Dublin Society, 1983), on the Geological Survey of Ireland; also interesting are J. Secord, "The Geological Survey of Great Britain as a research school, 1839-1855," *History of Science* 24 (1986): 223-275; B. Cohen, "Surveying nature: environmental dimensions of Virginia's first scientific survey, 1835-1842," *Environmental History* 11 (2006): 37-69; and D. Kumar, "Problems in science administration: a study of the scientific surveys in British India, 1757-1900," in P. Petitjohn et al., eds., *Science and empires: historical studies about scientific development and European expansion* (Dordrecht: Kluwer, 1992), 269-280. An important institutional history is M. Aldrich, *New York State Natural*

types of science, we have to turn to insights from neighbouring domains. One of the most important of these is the recent attention to the history of "field science," admittedly chiefly with respect to ecology and other life sciences, but one which goes a long way towards establishing (or rediscovering) the outdoors, in all its variety, as a meaningful site for the production of scientific knowledge.[11] The central fact of the recent historiography of science is that the dominance since the 1980s of a range of sociological approaches, more or less closely related to each other, has worked to understand the laboratory as the preeminent and definitive locale where science occurs. And yet it makes no more sense to study field science without attending to what went on the field, than it once did to ignore the details of laboratory life. Thus, as important as this work has been, its models should not be seen as normative for the field sciences, where the environment of work gives rise to entirely different relationships between the scientist and the objects of nature under study. Surveying by definition is a work of extension: the application of a process not just in one or several places but just about everywhere over a territory. It was for just this reason that William Logan literally had to remove his trousers in order to pursue his scientific work, an eventuality that one strains to imagine

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History Survey, 1836-1842 (Ithaca, NY: Paleontological Research Institution, 2000); see also W. Hendrickson, "Nineteenth-century state geological surveys: early government support of science," *Isis* 52 (1961): 357-71; and for an instructive comparative case in Australia, P. O'Shea, *Beneath our feet: celebrating 150 years of the Geological Survey of Victoria* (Melbourne: Department of Primary Industries, 2003).

[11] See, to begin with, H. Kuklick & R. Kohler, eds., *Science in the field, Osiris* (2nd series) 11 (1996); for more detailed studies see also J. Camerini, "Remains of the day: early Victorians in the field," in B. Lightman, ed., *Victorian science in context* (Chicago: University of Chicago Press, 1997), 354-377; R. Kohler, "Place and practice in field biology," *History of Science* 40 (2002): 189-210; and R. Kohler, *Landscapes and labscapes* (Chicago: University of Chicago Press, 2002). A classic and still valuable work is D. Allen, *The naturalist in Britain* (Princeton, NJ: Princeton University Press, new ed., 1994).

arriving in a lab. This chapter's epigraph is thus far from frivolous – it underscores important factors that sets geological surveying apart from laboratory science: the need to move from place to place, the need to adapt to local environmental conditions, and the reality that the scientist will become personally implicated in the research.

Histories of geology are of course always willing to recognize the centrality of field experience to the science; David Oldroyd, Martin Rudwick, and Hugh Torrens are among the leaders in this regard.[12] But even here the emphasis has more often been on the creation of original intellectual content – such as new theories or stratigraphic systems – and not on the nature of fieldwork itself and its relationship to the mode of production of routine data, in which surveying largely consists. Thus, in addition to the existing specialist literature, the present study is inspired equally by two crucial historiographical developments of the last decade or so: first, the application of historical geography perspectives (most importantly, the multiple roles of "place" and "space") to science studies, influentially introduced by, among others, sociologists such as Steven Shapin and Bruno Latour, and exemplified more recently by David Livingstone, a historical geographer.[13] Even here, however, the dominant application of these

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[12] See in particular Oldroyd, *Highland controversy* (p. 7); M. Rudwick, "Geological travel and theoretical innovation: the role of 'liminal' experience," *Social Studies of Science* 26 (1996): 143-159; and H. Torrens, *The practice of British geology, 1750-1850* (Burlington, VT: Ashgate, 2002).

[13] On travel and measurement – the concepts of "centres of calculation" and "action at a distance" – a still-essential early text is B. Latour, *Science in action* (Cambridge, MA: Harvard University Press, 1987), especially chaps. 4 and 6; on "circulating reference" and soil samples, see B. Latour, *Pandora's hope* (Cambridge, MA: Harvard University Press, 1999), chap. 2. For Shapin, see S. Shapin, "Placing the view from nowhere: historical and sociological problems in the location of science," *Transactions of the Institute of British Geographers* 23 (1998): 5-12; see also A. Ophir & S. Shapin, "The place of knowledge: a methodological survey," *Science in Context* 4 (1991): 3-21. The current starting point is D. Livingstone, *Putting science in its place* (Chicago: University

perspectives has been to indoor spaces (laboratories, museums, public places); relatively few studies so far have addressed the outdoor world of field science.[14] More useful for the case of geological surveying is the literature on travel and exploration, which ranges over themes such as the Enlightenment, gentlemanly status, the nature of observation, and imperialism.[15] Also important for the present study is another geographic perspective on science, James Secord's framing of the problem of "circulating knowledge," which provides a way to think about the various ways (reports, museums, exhibitions, maps) that geological survey results were presented to the public, to the government, and to other scientists.[16]

The second factor to acknowledge here is the rapid growth of historical geography's close cousin (and in some ways mirror image), environmental history.[17] Together, they provide a means of accounting for the active role of place in shaping human activities, and simultaneously for the impact of these activities on places

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of Chicago Press, 2003). For geology, see M. Shortland, "Darkness visible: underground culture in the golden age of geology," *History of Science* 32 (1994): 1-61.

[14] See the review in S. Naylor, "Introduction: historical geographies of science – places, contexts, cartographies," *British Journal for the History of Science* 38 (2005): 1-12; but see also the studies in the history of geography in the same volume, S. Naylor, ed., Special issue: Historical geographies of science, *British Journal for the History of Science* 38.1 (March 2005); as well as S. Naylor, "The field, the museum and the lecture hall: the spaces of natural history in Victorian Cornwall," *Transactions of the Institute of British Geographers* 27 (2002): 494-513.

[15] See especially D. Outram, "On being Perseus: new knowledge, dislocation, and Enlightenment exploration," in D. Livingstone and C. Withers, eds., *Geography and enlightenment* (Chicago: University of Chicago Press, 1999), 281-294; and F. Driver, *Geography militant: cultures of exploration and empire* (Oxford: Blackwell, 2001).

[16] J. Secord, "Knowledge in transit," *Isis* 95 (2004): 654-672.

[17] For a wide-ranging review, see A. Baker, *Geography and history* (Cambridge: Cambridge University Press, 2003); also useful is M. Evenden, "A view from the bush: space, environment and the historiography of science," *Scientia Canadensis* 28 (2005): 27-37; a valuable Canadian case is S. Zeller, "Classical codes: biogeographical assessments of environment in Victorian Canada," *Journal of Historical Geography* 24 (1998): 20-35.

themselves. Moreover, the history of the field sciences has an important contribution to make to environmental history, in explaining how "environmental knowledge" comes to exist: that is, through the attribution of scientific knowledge (here, geological data in the form of the name of a particular stratigraphic unit) to specifically-identified locations.[18] While scientific knowledge (stereotypically, the laws of physics) is in principle exactly that which is place-independent (true everywhere), environmental knowledge is that which is true at a specific point. The key fact to appreciate here is that geological surveying (or stratigraphy generally) has a special relationship to place, in that many of its observations – for example, the "dip" (angle of inclination) of strata, crucial to extrapolating from outcrop to the unseen – intrinsically inhere in *in situ* formations and cannot be abstracted from the field by way of specimens. Far from being routine, geological surveying thus emerges as *the* field science par excellence, because it demands the personal presence of the scientist at each and every point over the territory to be described. The geologist is implicated in the production of knowledge literally every step of the way, and this in turn means that the survey is just as much about the surveyor as about the land. I believe that it is crucial, when using scientific knowledge to interpret the past, as environmental historians often do, to realize that this scientific knowledge itself has a past, and one that in many ways is part of the landscape.[19]

This attention to travel and exploration, en route to cartography, requires the consideration of another equally fresh set of historiographical perspectives. Probably the

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[18] This can fruitfully be compared to the concept of "geographical knowledge" for early twentieth-century large-scale land economic survey maps, as developed in A. Checkovich, "Mapping the American way: geographical knowledge and the development of the United States, 1890-1950," Ph.D. thesis, University of Pennsylvania, 2004.
[19] See also Evenden, "A view from the bush."

single most influential study in framing this dissertation has been Graham Burnett's *Masters of all they surveyed*, which demonstrates with an unmatched (and perhaps unmatchable) analytical richness what can be done in reading a surveyor's field experience in comparison with what ends up on the map.[20] Burnett's study, set in British Guiana in a period contemporary with Logan's early work in Canada, is part of a vibrant literature on (non-geological) exploring, surveying, and mapping in the nineteenth-century British empire.[21] Following above all J. B. Harley, historians of cartography learned many years ago to see maps as unfailingly rhetorical and political documents, inevitably laden with telling simplifications, abstractions, omissions, and selective inclusions.[22] Nevertheless, this observation still needs to be extended to the work of geological surveys, whose products are among the most sophisticated in the category of thematic mapping.[23] It is here that the role of the state becomes more evident, since geological surveys are at once scientific practice and state projects, designed to gather, harness, and deploy place-specific knowledge for clear political ends – from mineral

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[20] D. G. Burnett, *Masters of all they surveyed* (Chicago: University of Chicago Press, 2000). This approach finds one of its key inspirations in the work of Australian critic Paul Carter; see in particular P. Carter, *The road to Botany Bay* (London: Faber & Faber, 1987), and P. Carter, "Gaps in knowledge: the geography of human reason," in D. Livingstone & C. Withers, eds., *Geography and enlightenment* (Chicago: University of Chicago Press, 1999), 295-318.
[21] See the crucial and wide-ranging Driver, *Geography militant*; another instant classic and frequently cited study is M. Edney, *Mapping an empire* (Chicago: University of Chicago Press, 1997), on the Great Trigonometric Survey of India.
[22] J. B. Harley, "Maps, knowledge, and power," in D. Cosgrove and S. Daniels, eds., *The iconography of landscape* (Cambridge: Cambridge University Press, 1988), 277-312; J. B. Harley, *The new nature of maps* (Baltimore: Johns Hopkins University Press, 2001); another core work is D. Wood, *The power of maps* (New York: Guilford Press, 1992).
[23] The foundational work here is M. Rudwick, "The emergence of a visual language for geological science 1760-1840," *History of Science* 14 (1976): 149-195. For an example of the applicability of critical cartographic perspectives to the history of planetary science, see K. M. Lane, "Geographers of Mars: cartographic inscription and exploration narrative in late Victorian representations of the red planet," *Isis* 96 (2005): 477-506.

rights to settlement plans.[24] In this sense, pre-Confederation Canada shares a context not only with Britain and various U.S. states, but also with other colonies (both settler and occupation) in the British world. And thus, approaches to the question of science and empire also have much to offer in framing this dissertation.

Having argued that the idea of a geological survey is ripe with analytic potential, albeit yet unfulfilled, we can now proceed to ask what is specifically "of Canada" in the case of Logan's project – to what extent did it partake of broader phenomena of colonial government, and to what extent was it a unique domestic (or proto-national) manifestation? Here, the existing literature is broader and deeper at both the general and specific levels.[25] Robert Stafford has well mined the connections between geological surveying and the British empire, and above all the role of the eminence grise of nineteenth-century British exploration, Roderick I. Murchison.[26] It must be said, however, that this perspective risks reducing the role of colonial survey directors to mere exemplars of a more general metropolitan idea and of overstating the practical

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[24] A similar description of geological surveys is advanced by Kuklick & Kohler, "Introduction," *Science in the field*, pp. 7-10.

[25] Earlier foundational works in the history of Canadian natural science include C. Berger, *Science, God and nature in Victorian Canada* (Toronto: University of Toronto Press, 1983); T. Levere & R. Jarrell, eds., *A curious field-book; science & society in Canadian history* (Toronto: Oxford University Press, 1974). For a detailed overview, see S. Zeller, "Nature's Gullivers and Crusoes: the scientific exploration of British North America, 1800-1870," in J. Allen, ed., *North American exploration, volume 3: A continent comprehended* (Lincoln, NE: University of Nebraska Press, 1997), 190-243.

[26] R. Stafford, "Geological surveys, mineral discoveries, and British expansion, 1835-71," *Journal of Imperial and Commonwealth History* 12.3 (May 1984): 5-32; R. Stafford, *Scientist of empire* (Cambridge: Cambridge University Press, 1989); R. Stafford, "Annexing the landscapes of the past: British imperial geology in the nineteenth century," in J. MacKenzie, ed., *Imperialism and the natural world* (Manchester: Manchester University Press, 1990), 67-89; see also J. Secord, "King of Siluria: Roderick Murchison and the imperial theme in nineteenth-century British geology," *Victorian Studies* 25 (1982): 413-442.

significance of British geological survey director H. T. De la Beche, who though certainly an important friend and ally of Logan's, was in no sense his manager. More recently, colonial science and in particular the British empire have received renewed historical attention, to the extent that older schematic models of the diffusion of metropolitan science from "centre" to "periphery" have long since broken down and the emphasis has shifted rather to local studies, local conditions, local knowledges, and "multiple engagements."[27] Thus, the best current treatment of Canadian geological surveying from the point of view of empire argues that it was Logan and not Murchison who extended an imperial nomenclature (his "Laurentian" formation) over North American and beyond.[28] Whether one takes this perspective or another, it is certainly true that such a decentred (or locally centred) approach well suits geological surveying, a science in which what happens at the metropolitan headquarters (the office, the museum) is highly dependent upon what happens at a thousand far-flung points in the field – and not the opposite.

Of course, the fact that so many jurisdictions launched geological and other natural history surveys from the 1830s onwards bears witness to the extent to which these projects were not merely about scientific curiosity but more importantly about knowing

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[27] See L. Schiebinger, "Forum introduction: the European colonial science complex," *Isis* 96 (2005): 52-55; and M. Harrison, "Science and the British empire," *Isis* 96 (2005): 56-63; another good starting points is R. MacLeod, ed., *Nature and empire: science and the colonial enterprise*, *Osiris* (2nd series) 15 (2000); especially his "Introduction," pp. 1-13. The now widely-abandoned original classic model of "diffusion" is G. Basalla, "The spread of Western science," *Science* 156 (1967): 611-622; a more nuanced alternative is R. MacLeod, "On visiting the 'moving metropolis': reflections on the architecture of imperial science," in N. Reingold and M. Rothenburg, *Scientific colonialism: a cross-cultural comparison* (Washington, D.C.: Smithsonian Institution Press, 1987), 217-249.
[28] S. Zeller, "Colonial world as a geological metaphor"; for another, somewhat older interpretation, see W. Eagan, "The Canadian Geological Survey: hinterland between two metropolises," *Earth Sciences History* 12 (1993): 99-106.

and organizing the land, and above all bringing it under bureaucratic administration.[29] Governments everywhere sought to measure, classify, divide, settle, and exploit their territory. On the one hand, thus, Logan's survey was absolutely of a piece with similar projects elsewhere (albeit perhaps a larger and better-executed piece than some); but on the other hand it should never be forgotten that the Geological Survey of Canada was voted and paid for by the colonial legislative assembly, and represented more the desires of Canadians to live up to the industrial ideal of the motherland, than any external attempt to impose a resource-extraction regime on an occupied territory.[30] In this sense, I would argue that Logan's survey must also be approached within the context of Canadian colonial state formation, rather than as an example of primarily imperial science.[31] Several additional works form an important part of the context here, including Ian Mackay's "liberal order framework," which proposes to reconsider Canada as a "project of rule"; Bruce Curtis's studies of statistics and governmentality; Bruce Braun's analysis

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[29] Useful comparative works here are R. Drayton, *Nature's government: science, imperial Britain, and the 'improvement' of the world* (New Haven, CT: Yale University Press, 2000); T. Dunlap, *Nature and the English diaspora* (Cambridge: Cambridge University Press, 1999); and J. Weaver, *The great land rush and the making of the modern world, 1650-1900* (Montreal & Kingston: McGill-Queen's University Press, 2003).

[30] For two characteristic perspectives on the important question of Canada's place in the British empire, see P. Buckner, "Making British North America British, 1815-1860," in C. Eldredge, ed., *Kith and kin: Canada, Britain and the United States from the Revolution to the cold war* (Cardiff: University of Wales Press, 1997), 11-44; and G. Martin, "'Our Advices from Canada are Unimportant': *The Times* and British North America, 1841-1861," in Eldredge, *Kith and kin*, 61-93; or, equally, G. Martin, "Canada from 1815," in A. Porter, ed., *The Oxford history of the British Empire, Volume III: The nineteenth century* (New York: Oxford University Press, 1999), 522-545; and P. Buckner, "Was there a 'British' empire? *The Oxford History of the British Empire* from a Canadian perspective," *Acadiensis* 32.1 (Autumn 2002): 110-28.

[31] A good starting point is A. Greer & I. Radforth, eds., *Colonial leviathan: state formation in mid-nineteenth-century Canada* (Toronto: University of Toronto Press, 1992. On the specific topic of Logan's mineral displays for international exhibitions, see the nuanced and insightful reading offered by E. Heaman, *The inglorious arts of peace* (Toronto: University of Toronto Press, 1999), chap. 6.

of George Mercer Dawson's post-Confederation geological work in British Columbia (a rare case of attention to earth science in this theoretical context); and John Walsh's work on land surveying in the Ottawa-Huron tract.[32] Together, these strongly suggest that a fruitful way of assessing the broader significance of Logan's geological survey is to examine how it helped to create and administer Canadian territory.

Mid-nineteenth-century Canada was a well-defined historical unit, consisting of the union (in 1841) in one province of the old colonies of Upper and Lower Canada (now redubbed Canada West and Canada East), from the aftermath of the failed rebellions of 1837-38 up to Confederation (in 1867).[33] This period saw the effective completion of settlement in the agriculturally-viable regions of the colony, along with the waning of British trade preferences, both of which inspired ideas of developing the domestic economy along industrial lines. The state thus had a profound need for concrete information about what its enormous tracts of non-agricultural land might be good for, in particular on the northern shores of Lakes Huron and Superior, which also happened to

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[32] I. Mackay, "The liberal order framework: prospectus for a reconnaissance of Canadian history," *Canadian Historical Review* 81 (2000): 617-645, p. 620; B. Curtis, *The politics of population* (Toronto: University of Toronto Press, 2001), and B. Curtis, "Textual economies and the presentation of textual material: charts, tables, and texts in 19th century public education," *Scientia Canadensis* 29 (2006): 3-28; B. Braun, "Producing vertical territory: geology and governmentality in late Victorian Canada," *Ecumene* 7 (2000): 7-46; J. Walsh, "Landscapes of longing: colonization and the problem of state formation in Canada West," Ph.D. thesis, University of Guelph, 2001.

[33] The term "Canada" is used in its pre-Confederation provincial sense throughout this dissertation. Useful background works on this period range from the classic J. M. S. Careless, *The union of the Canadas: the growth of Canadian institutions 1841-1857* (Toronto: McClelland & Stewart, 1967), see pp. 148-49; to the invaluable L. Gentilcore, ed., *Historical atlas of Canada, Volume II: The land transformed, 1800-1891* (Toronto: University of Toronto Press, 1993); see also Zaslow, *Reading the rocks*, chap. 1.

be still-unceded Indian (First Nations) territory.[34] Meanwhile, in Montreal, the leading Canadian city and future home of the Geological Survey, the question of future industrial development was becoming increasingly pertinent.[35] William Logan, the Survey's future director, was well-connected to the Montreal business community through his brother James, who was involved from time to time in banking, railroad, and mining enterprises.[36] Although its birth was widely supported, the incipient Geological Survey represented different promises to different groups.[37] Not surprisingly, this fact means that subsequent historians have been able to see within it a wide range of meanings.

For institutional historians such as Morris Zaslow, the GSC set the standard and the pattern for scientist-led federal government research in Canada; Logan was thus above all an institution-builder, a first-class scientist, and not incidentally a skilled administrator and lobbyist.[38] For historians of British imperial science like Robert Stafford, the GSC was part of a close-knit worldwide collaboration to standardize and disseminate stratigraphic nomenclature; Logan appears here as a colonial member of a metropolitan (London) confraternity.[39] Equally, however, a noted historian of Canadian science, Richard Jarrell, has argued that it was quantitatively very similar to U.S. science

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[34] An enlightening resource here is the catalogue, J. Winearls, *Mapping Upper Canada 1780-1867* (Toronto: University of Toronto Press, 1991).
[35] For context, see G. Tulchinsky, *The river barons* (Toronto: University of Toronto Press, 1977); R. Lewis, "A city transformed: manufacturing districts and suburban growth in Montreal, 1850-1929," *Journal of Historical Geography* 27 (2001): 20-35; and S. Olson, "Ethnic partition of the work force in 1840s Montréal," *Labour/Le Travail* 53 (Spring 2004): 159-202.
[36] Tulchinsky, *River barons*, passim.
[37] For details of the origins of the GSC, see Zeller, *Inventing Canada*, chap. 1-2.
[38] Zaslow, *Reading the rocks*, chaps. 2-5.
[39] Stafford, "Annexing the landscapes of the past"; Stafford, *Scientist of empire*, see pp. 66-67, 198-200.

and barely linked to "some nebulous British scientific empire."[40] On the contrary, others have advanced the hypothesis (if not necessarily supported by the balance of evidence) that Logan was really concerned only with earning the approbation of his elite gentlemanly peers in pursuit of a merely ornamental science, and that in essence every public sentiment he ever uttered in support of practical applications and economic utility was a charade.[41] However, the most thoroughly-developed and influential interpretation of the GSC has been Suzanne Zeller's cultural and intellectual history approach, which emphasizes the contributions of natural knowledge generated by "inventory science" such as geological surveying to the idea of a future Canadian state, that is, the Confederation of British North American colonies. In Zeller's view, Logan emerges as a creative and ambitious visionary who followed his geological formations across colonial boundaries.[42]

It would be easy to say that each interpretation contains a larger or smaller element of truth; and furthermore that this variety indicates that Logan, although prolific, was in fact quite private, and kept his personal motives (if indeed he had any that were different from the goals of the GSC, which is far from certain) to himself. In this sense,

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[40] R. Jarrell, "British scientific institutions and Canada: the rhetoric and the reality," *Transactions of the Royal Society of Canada*, ser. 4, 20 (1982): 533-547, p. 547; see also R. Jarrell, "Science and the state in Ontario: the British connection or North American patterns?," in R. Hall et al., eds., *Patterns of the past: interpreting Ontario's history* (Toronto: Dundurn Press, 1988), 238-254.

[41] N. Christie, "Sir William Logan's geological empire and the 'humbug' of economic utility," *Canadian Historical Review* 75 (1994): 161-204. Needless to say, this view of Logan is not shared by any of the many historians who have read his original reports and correspondence, or considered the vast quantities of personal time he poured into practical work such as collecting unglamorous rocks or copying voluminous reports longhand. Like any conspiracy theory, this perspective requires the historian to believe that the bulk of the surviving evidence was created with the express intent to mislead.

[42] One concrete example was the need for Canada to gain access to the coal reserves it lacked, which could be found in Nova Scotia and potentially in the west as well. Zeller, *Inventing Canada*, pp. 105-109; Zeller, "Colonial world as a geological metaphor."

William Logan as a historical character is "underdetermined," which is why, although much has been written about him, more remains to be said. Rather than revisit the facts of Logan's accomplishments and of the history of the Geological Survey generally, which have already been so thoroughly treated by Zaslow, Zeller, and others, my goal in this dissertation is to get at *how* Logan worked. For the first time, I want to examine what actually went on in the field, and later how that experience was transformed and presented to the public as facts for their consumption. (This is not to be seen as a critique of the significance of Logan's science, any more than the explication of a general's or a politician's strategy diminishes their results.) Whereas Zaslow and Zeller have drawn on an enormous canvas, I propose instead a collection of close readings of selected episodes. No attempt is made to account for every aspect of Logan's career – for example, the various geological controversies in which he occasionally took (usually a small) part, which interested previous generations of historians of science, with their focus on *what* was known, when, and first by whom.[43] Although I do not dispute, and indeed affirm that stratigraphy (the science of the superposition of discrete, identifiable layers of deposited rock, capable of regional and global correlation, and organized into a single geochronological sequence) was central to the work of a geological survey, I turn my attention instead to the field practices which made stratigraphy possible. The geometry and geography of strata could only be observed in the wild, by an expert scientist – this was the core problem of Logan's early surveying, and the reason why it is impossible to

[43] For example, W. Eagan, "'I would have sworn my life on your interpretation': James Hall, Sir William Logan and the 'Quebec group'," *Earth Sciences History* 6 (1987): 47-60; C. Schneer, "The great Taconic controversy," *Isis* 69 (1978): 173-191; C. O'Brien, "*Eozoön canadense*: 'the dawn animal of Canada'," *Isis* 61 (1970): 206-223.

come to conclusions about the GSC before addressing the biography and identity of Logan himself.

Scientific biography, once a dominant mode in the history of science, and subsequently eclipsed in the 1970s and 80s, has been undergoing a renaissance in more recent years.[44] Among the new themes are attention to how historical biographies have created scientific identities over time (including studies of commemoration), as well as examinations of the adoption and deployment of such identities as an element in a scientist's rhetorical toolbox.[45] It is an intriguing fact that William Logan, despite his status as Canada's foremost nineteenth-century scientist, has attracted no extended biographical treatment since the official "life & letters" by B. J. Harrington, published in 1883.[46] Indeed, the reality is that Harrington's biography, in conjunction with a nostalgic and admiring pamphlet written in later years by one of Logan's protégés, Robert Bell, have largely carried the day, with their characterizations being frequently repeated in the secondary literature.[47] While the present dissertation, as already cautioned, is to no great extent biographical, it does hope to suggest methods and approaches by which a new understanding of Logan can be reached. In particular, it is necessary to problematize the very elements of Logan's personality that have been taken for granted – his arduous fieldwork, his ragged clothing, his taste for country food, and in general his particular

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[44] A sign of the revival is M. Shortland & R. Yeo, eds., *Telling lives in science* (Cambridge: Cambridge University Press, 1996).

[45] On commemorating scientists, see Part I of P. Abir-Am & C. Elliot, eds., *Commemorative practices in science*, *Osiris* (2nd series) 14 (1999). Particularly important in Logan's case, is the possibility of seeing the field geologist as a natural "persona," in the sense developed by L. Daston & H. O. Sibum, "Introduction: scientific personae and their histories," *Science in Context* 16 (2003): 1-8.

[46] Harrington, *Life of Logan*. For genealogical context, see G. Home, *History of the Logan family* (Edinburgh: Waterston, 1934).

[47] R. Bell, *Sir William E. Logan and Geological Survey of Canada* (Ottawa, [1910]).

masculine demeanour. Gender considerations enter into studies of all sciences, and possibly nowhere more strongly than in field geology. Here, the work of scholars such as Naomi Oreskes, Bruce Hevly, Jan Golinski, and Robert Nye is important, while work on masculine wilderness culture in Canadian history by Adele Perry and Caroline Podruchny furnishes an equally pertinent point of comparison.[48]

Biography can in fact be an important tool in deepening our understanding of how the field sciences functioned. On the one hand, the professional elements of a nineteenth-century geological career are relatively well-understood.[49] In a science whose roots were strongly gentlemanly, the directorship of a geological survey was an acceptably honourable post, but one that nevertheless implied a full-time commitment to administrative work, and thus was quite different from the avocational pursuits of earlier

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[48] Also important is a large literature on gender and historical geography; see chapter 3. N. Oreskes, "Objectivity or heroism? On the invisibility of women in science," *Osiris* (2nd series) 11 (1996): 87-113; B. Hevly, "The heroic science of glacier motion," *Osiris* (2nd series) 11 (1996): 66-86; J. Golinski, "The care of the self and masculine birth of science," *History of Science* 40 (2002): 125-145; R. Nye, "Medicine and science as masculine 'fields of honor'," *Osiris* (2nd series) 12 (1997): 60-79; A. Perry, "Bachelors in the backwoods: white men and homosocial culture in up-country British Columbia, 1858-71," in R. Sandwell, ed., *Beyond the city limits: rural history in British Columbia* (Vancouver: University of British Columbia Press, 1999): 180-194; A. Perry, *On the edge of empire* (Toronto: University of Toronto Press, 2001), chap. 1; C. Podruchny, "Baptizing novices: ritual moments among French Canadian voyageurs in the Montreal fur trade, 1780-1821," *Canadian Historical Review* 83 (2002): 165-195.

[49] In general, see the still-enlightening R. Porter, "Gentlemen and geology: the emergence of a scientific career, 1660-1920," *Historical Journal* 21 (1978): 809-836; for North American studies that illuminate Logan's context (although he was perhaps unusual in keeping the same job over such a long period of time), see P. Lucier, "Commercial interests and scientific disinterestedness: consulting geologists in antebellum America," *Isis* 86 (1995): 245-267; and J. Newell, "James Dwight Dana and the emergence of professional geology in the United States," *American Journal of Science* 297 (1997): 273-282. Biographies, mainly narrative, of Logan's U.S. contemporaries include: E. Berkeley & D. Berkeley, *George William Featherstonaugh: the first U.S. government geologist* (Tuscaloosa: University of Alabama Press, 1988); P. Champlin, *Raphael Pumpelly: gentleman geologist of the gilded age* (Tuscaloosa: University of Alabama Press, 1994).

generations. On the other hand, as already outlined, what we now require is a much greater attention to scientists' personal field experience. Here, I have been inspired by the historical literature on bodies and senses, as exemplified once again by Steven Shapin in the history of science, and by Joy Parr in Canadian history.[50] In order to understand how Logan married science (in the abstract) with surveying (the overwhelming local), we need to understand what he did and how he felt as he trekked from outcrop to outcrop, measured angles and thickness of rock layers, paced distances along miles of coast (apparently in varying states of undress), climbed mountains, and hauled away bags of geological specimens. This is crucial because the geological surveyor himself was the central instrument of observation and data collection.[51] Fortunately, in Logan's case, it is possible to recover this firsthand experience, thanks to a nicely complementary set of surviving records documenting several key years of fieldwork, and beyond that more generally the various ways in which the geological knowledge resulting from fieldwork circulated in the scientific information economy.

This dissertation is based on a variety of printed and manuscript sources; in what is truly a sign of our times, a great proportion of these have become freely available in

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[50] See S. Shapin, "The philosopher and the chicken: on the dietetics of disembodied knowledge," in C. Lawrence and S. Shapin, eds., *Science incarnate: historical embodiments of natural knowledge* (Chicago: University of Chicago Press, 1998), 21-50, as well as that volume generally; J. Parr, "Notes for a more sensuous history of twentieth-century Canada: the timely, the tacit, and the material body," *Canadian Historical Review* 82 (2001): 720-745; J. Parr, "Smells like?: sources of uncertainty in the history of the Great Lakes environment," *Environmental History* 11 (2006): 269-299; for overall theoretical background, see D. Howes, *Sensual relations: engaging the senses in culture and social theory* (Ann Arbor, MI: University of Michigan Press, 2003).

[51] For an example of a similar approach, see K. Raj, "When human travellers become instruments: the Indo-British exploration of Central Asia in the nineteenth century," in M. Bourguet, C. Licoppe and H. Sibum, eds., *Instruments, travel and science* (London: Routledge, 2002), 156-188, and other papers in that volume generally.

digital editions online in the time since this project was begun.[52] Readers are thus invited to follow up on the footnotes at any point and evaluate my interpretations for themselves. Collections of Logan manuscripts exist at several repositories, most notably McGill University Archives, but also at the British Geological Survey archives at Keyworth, Nottinghamshire, at the National Museum of Wales in Cardiff, and at the National Library of Wales in Aberystwyth, where his 1843 and 1844 Gaspé travel journals are held.[53] These are above all the most crucial sources for the first half of this dissertation, because of their rich level of personal detail. While the field notebooks held in the GSC records at Library and Archives Canada contain the technical details of Logan's work, the journals take as their subject the person of the surveyor himself. They thus furnish an exceptional opportunity to answer the questions outlined above, in providing a rare up-close look at Victorian field science in the making.[54]

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[52] Including published reports, printed maps, and manuscript notebooks and journals, these are gathered together under Library and Archives Canada's web portal, "Written in stone: William E. Logan and the Geological Survey of Canada," http://www.collectionscanada.ca/logan/ [7 February 2007]; see Bibliography for details on which items are currently available in this form.

[53] See Bibliography for a complete list of sources. It should be noted that a substantial portion of the Logan letters at McGill are more or less routine incoming correspondence; these would nevertheless be useful for the writing of a biography.

[54] For an intriguing twentieth-century reading of a personal diary of fieldwork, see H. Lorimer & N. Spedding, "Locating field science: a geographical family expedition to Glen Roy, Scotland," *British Journal for the History of Science* 38 (2005): 13-33. In the Canadian context, explorers' journals have received some attention; see for example C. S. Houston, ed., with commentary by I. S. MacLaren, *Arctic artist: the journal and paintings of George Back, midshipman with Franklin, 1819-1822* (Montreal and Kingston: McGill-Queen's University Press, 1994); A. McEwen, *In search of the highlands: mapping the Canada-Maine boundary, 1839* (Fredericton, NB: Acadiensis Press, 1988). Soon to be published is an edition of Logan's 1845 journal of his expedition up the Ottawa River, edited by Charles Smith and Ian Dyck (Canadian Museum of Civilization). On surveyors' technical notebooks, see L. Gentilcore & K. Donkin, *Land surveys of southern Ontario: an introduction and index to the field*

Having explained several times that this dissertation is neither a biography of Logan, nor another history of the Geological Survey of Canada, it simply remains to say what it is. The structure of the text is essentially two-fold: in the first half I look in depth at Logan in the field, and in the second half I follow his results as they circulate through the fact economy of official reports, exhibitions and museums, and geological maps. In the first half the central questions are those of *how* – how the field was experienced and how knowledge was obtained. In the second half, I ask not only how knowledge circulated, but also what it represented to its various audiences. In sum, then, my dissertation tries to tell the story of how Canada came to be seen in geological terms, for Logan marks the beginning of modern geology in the colonial province of Canada; to a large extent, his geological understanding of the land has more in common with our own than with that of his predecessors. It is the story of how geological knowledge came out of the field and got onto the map. Although I follow Logan's personal thread closely throughout most of the text, in a few places I diverge in order to illuminate the broader context and thus relevance of his work. These topics include the cultural context of scientific observation in the 1830s (in chapter 2); the writing of the history of the discovery of the origin of coal (in chapter 2); the role of women in geology in the generations after Logan (in chapter 4); and the impact of the idea of the Canadian Shield on perceptions of Canada in the twentieth century (in chapter 6). The ultimate goal of these scenic lookouts is to suggest ways in which a study such as the present one might intersect with other, broader histories.

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notebooks of the Ontario land surveys 1784-1859 (Toronto: Department of Geography, York University, 1973).

Chapter 2 of this dissertation covers a relatively wide range of introductory topics: it sets the scene by laying out some of the observational precepts of 1830s geology, the context in which Logan first became a geologist in South Wales, his contributions to the understanding of how coal is formed, as an example of the importance of observation in place, and the circumstances under which his formal survey of Canada would begin.

Chapters 3 and 4 are case studies of Logan's first two years on the geological survey of Canada (1843, 1844). Both expeditions took place in the Gaspé peninsula of eastern Quebec, but they are otherwise a study in contrasts (coast/interior, small group/large group) and accordingly I emphasize different themes in each. Chapter 3 concerns scientific activities such as observation and recording, whereas Chapter 4 looks above all at the establishment of a social (in the sense of relations with others) and cultural (in the sense of practices) identity for a Canadian field geologist. While far from being the only case studies possible of Logan's fieldwork, these two seem like the best starting point, both because they capture Logan's early struggles and above all because they are so well supported by the personal journals. (It should be noted that, while field notebooks exist for most of Logan's expeditions and projects, in many cases they contain technical data only; others are a mixture of data and objective [third-person, passive voice] observations.)

Chapter 5 introduces the idea of "writing the rocks," in studying the various representational strategies used to put Canadian geology before the public. This chapter draws on the published annual reports of the GSC, as well as on the insights of book history and museum history. The 1850s, marked by a parliamentary Select Committee convened specifically to hasten the publication and dissemination of Logan's results, as well as by successful international exhibitions in London and Paris, remain a significant turning point in the progress of Logan's project.

Chapter 6 begins by focussing on the production of the general geological map of Canada, a substantial accomplishment, and one which occupied much of the 1860s, Logan's last decade on the survey. This chapter seeks out ways that geological knowledge was used by non-geologists. It also considers the importance of geological maps more generally, and in particular for the reimagination of Canadian territory that took place after the turn of the twentieth century.

Finally, the conclusion (chapter 7) assesses various ways of understanding what exactly it was that was important about the Geological Survey of Canada, and looks again at Logan's legacy as the very exemplar of the idea of a geologist. And now, so much for claims and assertions – let us begin.

CHAPTER 2

How To Observe

This chapter establishes two contexts: the first, for geology before Logan – the science he learned when he first took up an interest in the subject; and the second, for Logan before Canada – the geological work he did and the personal methods he developed before he came to the provincial survey. I look beyond traditional institutional and scientific histories in an effort to connect the rise of government surveys with a fundamental shift in the methodology of field geology from the 1830s onward. Just as stratigraphy and the quest for global stratigraphic correlation became the dominant concerns of British geology, the role of the field geologist evolved markedly beyond the Enlightenment model of the attentive traveller.[1] Where it had previously been adequate for observers to describe individual and occasional features of the landscape, stratigraphic geology now came to require a different kind of knowledge entirely, specifically combining expert knowledge of rocks and exact knowledge of place. This kind of double knowledge could only be obtained in the field: more than any other early Victorian science, geology required those who would be its leaders to work ceaselessly outdoors.

Geological surveying fundamentally engages with a tension between the need to gather observations over a very broad territory and the need for the utmost consistency in

[1] For thematic context, see M. Bourguet, "Landscape with numbers: natural history, travel and instruments in the late eighteenth and early nineteenth centuries," in M. Bourguet et al., eds., *Instruments, travel and science* (London: Routledge, 2002), 96-125; and for general background see M. Bourguet, "The explorer," in M. Vovelle, ed., *Enlightenment portraits*, trans. L. Cochrane (Chicago: University of Chicago Press, 1997), 257-315.

making those observations. The recognition that geological questions could only be answered by extended studies of large areas, not by the examination of isolated cases, prompted calls to democratize observation. But at the same time, the potency of the specialist in the field continued to grow. This chapter shows how these competing tensions formed the context of the geological practice that Logan brought to Canada.

The years around 1840 can be seen as significant for several reasons. For one, Jonathan Crary has argued that there was a fundamental shift in the cultural relationship between the observer and the observed in this period, in connection with the impact of new optical technologies that created new kinds of virtual images – an idea well-fitted to suddenly-quantitative, instrumentally-mediated geological surveying and mapping.[2] Furthermore, Richard Drayton has shown that the British government's revived interest in economically-useful science at this time was, especially in the case of botany, closely connected with imperial projects. Drayton's focus is Kew Garden, but it was part of a Department of Woods and Works that also formed the home of the newly-created Geological Survey and Museum of Economic Geology.[3] Geology was of course sufficiently important to the British government that coal statistics were officially kept at the Museum beginning in 1845.[4]

Scientifically, geology differs in an important way from botany, in that first-hand observation of field position is required to determine stratigraphic relationships. While

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[2] J. Crary, *Techniques of the observer* (Cambridge, MA: MIT Press, 1990); for a Canadian application, see L. McTavish, "Learning to see in New Brunswick, 1862-1929," *Canadian Historical Review* 87 (2006): 553-581.
[3] R. Drayton, *Nature's government* (New Haven, CT: Yale University Press, 2000), see especially pp. 174-5. For related documents on the museum, see PRO, WORK 17/7/1.
[4] For a general survey of the various significances of coal in Victorian Britain, see A. Briggs, *Victorian things* (Stroud: Sutton Publishing, rev. ed., 2003); particularly p. 260.

both amateur and commercial collectors did play a role in domestic geology, the extensive networks of colonial collectors that nourished British imperial botany had no real counterpart in geology, fossil and mineral specimens being much more inconvenient to ship long distances than pressed plants or, for that matter, other natural history materials such as bird skins.[5] Instead, the geological surveyors had to go out to the colonies themselves, for years or decades at a time. Accordingly, this dissertation focuses particularly on those aspects of geological practice which took place in the field, and on those aspects of field science that were unique to geology.

The first part of this chapter describes the ideas about the organization of vision that underlay field geology as Logan's geological work was beginning. The second part takes up this perspective and uses it to reach a better understanding of a crucial early step in Logan's career: his contribution to the theoretical debate on the origin of coal deposits. Finally, the chapter's conclusion uses the responses to a mineral questionnaire circulated by Logan, on the eve of his Canadian fieldwork, to underscore the differences between popular and specialist forms of geological knowledge.

2.1 'Eyes and No Eyes': A Moral Context for Observation

"Half a word fixed upon or near the spot, is worth a cart-load of recollection."[6]

According to Thomas Gray, the eighteenth-century poet, when it came to describing

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[5] On fossil collectors and the specimen trade, see S. Knell, *The culture of English geology* (Burlington, VT: Ashgate, 2000); for examples in the context of scientific knowledge-making, see M. Rudwick, *The great Devonian controversy* (Chicago: University of Chicago Press, 1985).

[6] Thomas Gray to William Palgrave, 6 Sept 1758. Letter 278, P. Toynbee & L. Wilbey, eds., *Correspondence of Thomas Gray* (Oxford: Clarendon, 1935), vol. 2, pp. 586-7. Thanks to Alexander Huber of the Thomas Gray Archive, Oxford University, for this reference.

nature there was just no substitute for being there in person. "Without accurate and particular observation," Gray reminded a friend who was touring Scotland in 1758, our memory of what we actually perceived is soon painted over by our imagination. Thus "we deceive ourselves," and others, when we allow fancy to rectify the blurred outlines and faint colours of defective memory. In other words, then, the practice of making detailed written observations, while one was still in the field, had equally aesthetic, moral, and epistemological value.[7] My goal in this section is to examine how these poetic virtues of keen perception and accurate recording became, by the mid-nineteenth century, a central part of the apparatus of formal government-sponsored scientific surveying projects.

By the 1830s, more than seventy-five years after Gray wrote the above words, the moral value of accurate observation was coming into its own as a popular movement. In this age of science, statistics, and social and political reform, it was all the more important that everyone took seriously his (and her) responsibility to record things as they actually were. This impetus was reflected in a little series planned by Charles Knight, entitled simply *How to observe*. Knight, a publisher, was printer to the Society for the Diffusion of Useful Knowledge, an organization whose primary purpose was the publication of small, cheap tracts aimed at a large audience.[8] In the event, only two

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[7] For the eighteenth-century context of these sentiments among provincial British clergy, and the extent of their relationship to natural history, see V. Jankovic, "The place of nature and the nature of place: the chorographic challenge to the history of British provincial science," *History of Science* 38 (2000): 79-113; on Thomas Gray see p. 111 (note 80).

[8] See R. Kinraide, "The Society for the Diffusion of Useful Knowledge and the democratization of learning in early-19th-century Britain." Ph.D. thesis, University of Wisconsin-Madison, 2006. For the cultural context of such publishing, see J. Secord, *Victorian sensation* (Chicago: University of Chicago Press, 2000), ch. 2, esp. pp. 48-51;

volumes were ever published: of these, the second, Harriet Martineau's sociological treatise on *Morals and manners* (1838), is by far the better-known today.[9] The first volume in the series was *Geology* (1835), written by Henry T. De la Beche, founding director of the recently-instituted Ordnance Geological Survey (as it was originally known); although it reached a second edition the following year, it is not among his more commonly-cited publications.[10] This volume also carried an "advertisement" to the reader, a preface by Henry Bellenden Ker explaining the rationale for the series. Like De la Beche, Ker was an active participant in the Society for the Diffusion of Useful Knowledge. The line he chose for his epigraph was Thomas Gray's maxim: "Half a word fixed upon, or near the spot, is worth a cart-load of recollection."[11]

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and J. Secord, "Progress in print," in M. Frasca-Spada & N. Jardine, eds., *Books and the sciences in history*, (Cambridge: Cambridge University Press, 2000), pp. 369-392.

[9] Harriet Martineau, *How to observe morals and manners*, ed. M. R. Hill (New Brunswick, NJ: Transaction Publishers, 1988).

[10] H. T. De la Beche, *How to observe. Geology*, 2nd edition (London: Charles Knight, 1836). De la Beche was a formerly independently-wealthy gentleman who turned to government employment after the collapse of his fortunes as a result of slave emancipation in Jamaica, where his family's sugar plantations were. See P. McCartney, "Henry De la Beche – a new kind of geologist," *Amguedda: Bulletin of the National Museum of Wales* 21 (Winter 1975): 13-28; and P. McCartney, *Henry De la Beche: observations on an observer* (Cardiff: Friends of the National Museum of Wales, 1977). For De la Beche's connection with contemporary reform movements, especially in sanitation and health, see also J. Secord, "The Geological Survey of Great Britain as a research school, 1839-1855," *History of Science* 24 (1986): 223-275, pp. 250-1. Secord locates De la Beche's political agenda in "Benthamite philosophical radicalism."

[11] H. B. K., "Advertisement," in De la Beche, *How to observe*, pp. iii-vi. Dated 1 June 1835. See also H. Martineau, *How to observe morals and manners* [1838], ed. M. Hill (New Brunswick, NJ: Transaction Publishers, 1988); Appendix II identifies H. B. K. as Ker. Gray's letter was first published in W. Mason, *The poems of Mr. Gray, to which are prefixed memoirs of his life and writings* (York, 1775), p. 272. In this edition, the quoted passage on observation carried the footnote: "Had this letter nothing else to recommend it, the advice here given to the curious traveller of making all his memoranda *on the spot*, and the reasons for it, are so well expressed, and withal so important, that they certainly deserve our notice."

Ker's theme in this preface to *How to observe: Geology* was the ability – and indeed responsibility – of ordinary people, both travellers and those who stayed at home, to make a productive contribution to scientific knowledge through disciplined and methodical observation. He cited the views of John Herschel, a leading British natural philosopher, in support of the notion that sciences like meteorology and geology were so geographically spread out that they "*can* only be effectually improved by the united observations of great numbers."[12] This programme promised not only improvement to science, but linked such benefits directly to the moral growth of the individual: by learning "how to observe" properly, Ker claimed, "the listless idler may be changed into an inquiring and useful observer, and may acquire the power of converting a dull and dreary road into a district teeming with interest and pleasure." He also mentioned the inspiration given to nascent observers by Gilbert White's *Natural history of Selbourne* (1789), one of the best-known and most influential of English local studies, and a text on machinery and manufacturing by Charles Babbage, the mathematician and computer pioneer, and also a prominent member of the Society for the Diffusion of Useful Knowledge.[13]

Of all the texts Ker cited, however, perhaps the most intriguing is a children's story called "Eyes and No Eyes, or the Art of Seeing."[14] This first appeared in the 1790s,

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[12] See J. Herschel, *Preliminary discourse on the study of natural philosophy* (London, 1830), a widely-read and influential work on scientific method. ODNB.

[13] That is, C. Babbage, *On the economy of machinery and manufactures* (London, 1832). See also Martineau, *How to observe morals*, p. 251. For the most recent scholarly reassessments of Babbage, Herschel, and others, see B. Lightman, ed., *Dictionary of nineteenth-century British scientists* (Bristol: Thoemmes Continuum, 2004).

[14] J. Aikin & A. L. Barbauld, *Evenings at home; or, the juvenile budget opened* (New York: Harper, n.d. Fifteenth edition, after 1823), pp. 242-48. Reprinted as A. Fyfe, ed., *Science for children* (Bristol: Thoemmes Press, 2003), vols. 1-2. Although Anna Laetitia

in a series called *Evenings at Home*, a collection of didactic literature that was originally written for Unitarian families but which nevertheless found a broad audience and was reprinted frequently throughout the nineteenth century.[15] "Eyes and no eyes" told the story of two boys: young Master William, who took great interest in the natural world and observed many interesting phenomena on a walk across the countryside, and Master Robert, who simply wanted to get home as quickly as possible, and saw nothing of interest because he did not look for it. Their teacher, Mr. Andrews, bemoaned the fact that so many people wasted their opportunities to learn anything of value, making an obvious moral point by comparing such unobservant folk to sailors who travelled the world and knew only the "signs of the tippling-houses in each port and the price and quality of liquor." According to Ker, the "advantages and pleasures to be derived from accurate observation have ... nowhere ... been better enforced than in the admirable tale of 'Eyes and no Eyes'."[16]

Although the *How to observe* series was meant to be useful to anyone and everyone, Ker's main interest was in travellers who visited regions not yet well-known to science. Such occasions represented real opportunities to add to existing knowledge; as Herschel had already pointed out in his remarks on geology, in the passage quoted by Ker, the key to making use of great numbers of observers is that they must be "widely

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Barbauld is the better-known literary writer, most of the stories in the collection, including this one, are by her brother John Aikin (1747-1822). In fact, John's son Arthur (1773-1854) was an aspiring geologist around this time; see H. Torrens, "Arthur Aikin's mineralogical survey of Shropshire 1796-1816 and the contemporary audience for geological publications," *British Journal for the History of Science* 16 (1983): 111-153.

[15] A. Fyfe, "Reading children's books in late eighteenth-century dissenting families," *The Historical Journal* 43 (2000): 453-473; Fyfe, "Young readers and the sciences," in Frasca-Spada & Jardine, *Books and the sciences*, 276-290. Thanks to Aileen Fyfe (National University of Ireland, Galway) for advice on this subject.

[16] Ker, "Advertisement."

dispersed." This made it all the more important for travellers to share their observations with others once they returned.[17] Ker himself had published an account of his travels in western North America twenty years earlier, and in "Eyes and no eyes" Master William was also a sort of traveller as he crossed the countryside and brought home a "handkerchief full of curiosities."[18] Certainly, the idea of the observant traveller was not itself new: common in the Enlightenment, it stretches back at the least to the Renaissance. What was new in the first half of the nineteenth century were two additional elements. The first of these was the drive to synthesize the observations of many under a single synoptic framework.[19] The principle of geographical distribution inherent in this social scheme for making knowledge meant that there also had to be a system for bringing disparate observations together under a synoptic view. And the most powerful means for reducing geographically-specific information to a single frame was of course the map.

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[17] This of course was an imperative dating as far back as the Renaissance; Ker at al. hardly had a monopoly on such values. For recent overviews, see N. Jardine, J. A. Secord, & E. C. Spary, eds., *Cultures of natural history* (Cambridge: Cambridge University Press, 1996), in particular the essays by M. Dettelbach, "Humboldtian science," pp. 287-304, and J. Browne, "Biogeography and empire," pp. 305-21; and F. Driver, *Geography militant* (London: Blackwell, 2001), especially ch. 3: "Hints to travellers." See also R. Sha, "The power of the English nineteenth-century visual and verbal sketch: appropriation, discipline, mastery," *Nineteenth-Century Contexts* 24 (2002): 73-100.

[18] H. Ker, *Travels through the western interior* (Elizabethtown, NJ, 1816). Published for subscribers in the New York and New Jersey area, this work also contains some biographical information.

[19] See the discussion of "Humboldtian" science below. For other fruitful approaches, which inform my analysis in a general sense, see M. Bravo, "Precision and curiosity in scientific travel: James Rennell and the Orientalist geography of the new imperial age (1760-1830)," in J. Elsner & J.-P. Rubiés, eds., *Voyages and visions: towards a cultural history of travel* (London: Reaktion Books, 1999), 162-183; and J.-P. Rubiés, "Instructions for travellers: teaching the eye to see," *History and Anthropology* 9 (1996): 139-190.

The early nineteenth century saw an explosion of "thematic" maps: those which superimposed colours and symbols on a topographic base map to show the distribution of a social or natural phenomenon such as population density, life expectancy, soil type, or indeed geology.[20] In fact, De la Beche's Geological Survey had begun as a project to colour Ordnance Trigonometrical Survey maps according to the age and type of rocks that existed at each point; it was formally approved as an ongoing project in the summer of 1835, just as *How to observe: Geology* was being prepared for the press.[21] Once again, the story of "Eyes and no eyes" that Ker had dwelt upon in projecting the How To Observe series illustrates the allure of maps: when Master William climbed to the top of windmill on the hill, he was amazed at all he could see. "What an extensive prospect! I counted fifteen church-steeples; and I saw several gentlemen's houses... and I could trace the windings of the river all along the low grounds.... But I'll tell you what I mean to do, sir.... I will go again, and take with me Cary's county-map, by which I shall probably be able to make out most of the places."[22] In the story, the tutor Mr. Andrews approved, and could only add to this notion by offering the use of his spy-glass for an even better view.

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[20] C. Delano-Smith & R. Kain, *English maps: a history* (Toronto: University of Toronto Press, 1999), ch. 7; A. H. Robinson, *Early thematic mapping in the history of cartography* (Chicago: University of Chicago Press, 1982). A particularly well-known early contribution was Heinrich Berghaus's *Physikalischer Atlas* (1838-1848).

[21] M. Rudwick, *The great Devonian controversy* (Chicago: University of Chicago Press, 1985), especially sections 4.6 and 5.8. On the British Geological Survey, see E. Bailey, *Geological Survey of Great Britain* (London: Thomas Murby, 1952); J. S. Flett, *The first hundred years of the Geological Survey of Great Britain* (London: HMSO, 1937); J. Secord, "The Geological Survey of Great Britain as a research school, 1839-1855," *History of Science* 24 (1986): 223-275; and R. Porter, "Gentlemen and geology: the emergence of a scientific career, 1660-1920," *Historical Journal* 21 (1978): 809-836.

[22] Aikin & Barbauld, *Evenings at home*, p. 245. John Cary (ODNB), among the important English cartographers of the period, was known for his highly detailed local maps; he also published William Smith's pioneering geological map of England and Wales in 1815.

What this brief episode illustrates, with the simplicity of a child's understanding, is the power of the belief that maps correspond with nature on a one-to-one basis.[23] If you look out over the landscape or look at map, it is the same thing, as William's plan to take the county map with him up to his vantage point attests. Where there is a church on the ground, there will be a church on the map; where the river itself meanders through the hills, so will the printed line. The map offers a kind of transparency in that you look not at the map itself but at the field, through the map.[24] Thus maps are a crucial administrative tool because they allow you to see at your desk what really exists in the field. By uniting "widely dispersed" observations, maps give a single person the power to see a composite picture generated by the eyes of many. This is all the more true when the knowledge in question is not simply the shape of the land itself but, on a thematic map, an abstract concept like the geological age of the rocks beneath the surface. Such knowledge was the province of experts because it could only be acquired through experience and careful judgment. It was the problem of how untrained but intelligent observers could gather consistent and comparable facts, even when they were far apart from each other, that *How to observe* was intended to address.

2.2 How to Observe?

Henry De la Beche began his 1835 treatise by explaining the basic principles of geological surveying and mapping. He showed how the underlying structure of an area

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[23] For starting points in the critical literature on cartography, see J. B. Harley, *The new nature of maps* (Baltimore: Johns Hopkins University Press, 2001), and D. Wood, *The power of maps* (New York: Guilford Press, 1992).
[24] For a discussion of various kinds of transparency, see the conclusion of the present chapter below, and Chapter 6.

could be inferred from the changes encountered in rock type as one moved over the surface of the earth, say along roads from point to point, using the example of the strata around London. Such inferences, he argued, were really no different in status from knowledge gained by direct observation, both types of which were displayed using the same visual tool, a vertical section. For example, "when we divide an apple or orange, we make a section which exposes their interior structure, which is otherwise concealed." The various types of geological sections all offered a special kind of vision into the hidden depths of the earth: "Some geological sections are natural, such as those afforded by sea-cliffs; some are artificial, such as deep cuts for roads and other purposes; while others are ideal, like that in the text, being constructed from the knowledge of various facts which render them either highly probable or almost certain."[25] In other words, he equated the visual products of a geological survey, its sections and maps, with an image of nature itself.

Most of *How to observe: Geology* was devoted not to the stratigraphical and paleontological facts that occupied full-time geologists, but to the basic physical processes that created the geological record, with an emphasis on making careful measurements of quantities such as rates of erosion, sea level rise and fall, and underground temperature. These phenomena were believed to be more or less constant (at least on a human observational scale), and thus well-suited to occasional monitoring

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[25] De la Beche, *How to observe*, pp. 2-4. See also M. Rudwick, "The emergence of a visual language for geological science 1760-1840," *History of Science* 14 (1976): 149-195. Rudwick shows how visual discourse came to parallel and even exceed the importance of textual description in geology by the end of this period.

according to a casual observer's convenience and inclination.[26] Nevertheless, there were certain types of catastrophic change that were also geologically significant, such as earthquakes and volcanoes. More than any other phenomenon, these demanded disciplined, synchronized observation by Herschel's "great numbers widely dispersed." De la Beche pointed out that important answers like the shape, direction, and intensity of earthquakes "can only be obtained by the combined observations of several persons," and that in order to be able to integrate the data, it was "important that a similar series of notes should be taken by various observers."[27]

More specifically, he advocated the use of a special earthquake-measuring instrument devised by Charles Babbage: a graduated dish, filled with a heavy liquid such as treacle, glass-covered and mounted outdoors on a pedestal. Such instruments would also have to be well-distributed geographically and "alike in every respect."[28] This strict observational regime represented the *How to observe* project at its most ambitious. In theory it left nothing to the observer except recording the direction and amplitude of disturbances in the liquid during tremors; the potential for scientific gain was built into the instrument, and into the arrangement of the network of observers itself. If this scheme could succeed, De la Beche, Babbage, and their friends in the Society for the Diffusion of Useful Knowledge might be on to a new way of doing science. Readers of

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[26] Whether such rates of change had been constant throughout the geological past, however, was a contested point at this time; few British geologists endorsed this, Lyell's most extreme form of uniformitarianism. See, for example, N. Rupke, *The great chain of history*, (Oxford: Clarendon Press, 1983).

[27] De la Beche, *How to observe*, p. 142. Again, mapping is crucial because it is the way to interpret a collection of geographical data. Such projects can be seen as an example of Latour's influential concept of science operating by "action at a distance"; B. Latour, *Science in action* (Cambridge, MA: Harvard University Press, 1987), pp. 219-232.

[28] De la Beche, *How to observe*, p. 143.

the SDUK's cheap, practical literature could be more than just consumers of scientific knowledge: they could help to produce it as well.

Theory is one thing, though; practice is another. There is no doubt that the 1830s were a decade of enthusiastic optimism about what might be accomplished; the same years saw the formation of the British Association for the Advancement of Science, an organization that did much to generate acceptance of such novel terms as "science" and "scientist."[29] Nevertheless, not everyone shared this brave vision of a new world of learning and technology, as demonstrated by an unabashedly hostile essay by the eminent Conservative writer and critic J. W. Croker in the *Quarterly Review*. Appearing in 1839, this essay set out to review Harriet Martineau's just-published *How to observe: Morals and manners*, but it began with a general indictment of the Society for the Diffusion of Useful Knowledge and what we might call its "observationalist" agenda. Croker wrote in his unsigned review that even a newborn baby knows "how to observe," and so if the publishers intended to begin with so basic an ability as that, it could only be that they intended to "proceed scientifically through the whole physical and mental economy of man" such that the next volume would no doubt describe "*How to suck*," to be written by "the professor of statistics in the London University ... with an appendix by Charles Babbage, Esq., on *artificial sucking*."[30] This nicely covered a number of sore points with

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[29] J. Morrell & A. Thackray, *Gentlemen of science* (Oxford: Clarendon Press, 1981). Geologists played a major role in this development. The BAAS also sponsored programmes of geographically-dispersed simultaneous research in a Herschelian/ Humboldtian mode, such as the system of geomagnetic observatories established around the world.

[30] [J. W. Croker], "Art. II. -- *How to observe. -- Morals and Manners*. By Harriet Martineau," *Quarterly Review* 63 (1839): 61-72, p. 61. On Croker, a founder of the Athenaeum Club in 1824, as author of this review, see M. Brightfield, *John Wilson Croker* (Berkeley: University of California Press, 1940), p. 422. See also Driver,

conservatives: the rise of social statistics; the establishment of the decidedly anti-establishment University College in London; and the proliferation of dubious new mechanical technologies.[31]

Even if correct observation was indeed a self-evident process, and required no explanation, this did not mean that everyone could or should observe scientifically. *Quarterly Review* writers (and readers) were not keen to see ordinary people caught up in the internal complexities of what might seem like irrelevant debates.[32] De la Beche, alleged Croker in referring to *How to observe: Geology*, "labours under the disadvantage of knowing a great deal of the matter he writes about, which makes his book rather perplexing to the uninformed, for whose use the society [SDUK] professes to publish." The idea that "every body should be constantly furnished with a cup half full of *treacle* to ascertain the direction of *earthquakes*," Croker called "ridiculous, and utterly impracticable," although perhaps "not uninteresting" to the "very young."[33] Indeed, there was inevitably going to be a gap between what metropolitan scientists wanted to obtain from field travellers, and what these private observers, circumscribed by their abilities, interests, and biases, were able to provide. In later years, in an effort to obtain

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Geography militant, p. 61. Babbage was a notoriously outspoken advocate of giving much greater national attention to science and technology.

[31] On the statistics debate, in which Babbage and the newly-formed British Association for the Advancement of Science were closely implicated, see M. Poovey, *A history of the modern fact* (Chicago: Chicago University Press, 1998), pp. 308-317. See also the useful review in B. Curtis, *The politics of population* (Toronto: University of Toronto Press, 2001), chap. 1; and in general T. Porter, *The rise of statistical thinking 1820-1900* (Princeton, NJ: Princeton University Press, 1986).

[32] Not that *QR* readers were themselves the ordinary people in question; they passed judgment on the SDUK though they were hardly its intended audience. For context and overviews of recent scholarship in an emerging field, see G. Cantor et al., *Science in the nineteenth-century periodical* (Cambridge: Cambridge University Press, 2004).

[33] Croker, *Quarterly Review*, p. 61.

accurate and reliable observations, the Royal Geographical Society (founded 1830) produced a manual called *Hints to travellers* (1854), but its miscellaneous and ecumenical content betrayed the lack of consensus even among scientists as to how and what travellers should observe.[34] An equally significant example of the genre was the Admiralty's *Manual of scientific inquiry: prepared for the use of officers in Her Majesty's Navy and travellers in general*, first published in 1849 under the editorship of none other than John Herschel.

If educated, experienced judgment was a criterion for making useful geographical observations, this was only more true when it came to geology. By the 1830s, it was not enough simply to gather rocks from the surface with a general note about their location: in order to deduce the hidden subterranean structure, a geologist had to be able to follow beds over great distances, decide whether two outcrops were of the same or different formations, and record the precise geometry of the strata, their angle ("dip") and direction of inclination (that is, deviation from the perfectly horizontal). These identifications and measurements were needed for any local field study; if the observations were part of a geographically-extensive geological survey then a host of topographical skills was required as well. The 1830s saw stratigraphy become the dominant form of British geology, as attention shifted from older debates about the physical and chemical origins of various rock types to the implementation of an international project to correlate strata of the same age, as identified by their fossil contents, and so establish a single unified geological history of the earth.[35] Despite the hopes of Herschel, Ker, and even De la

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[34] This is Driver's reading; see *Geography militant*, pp. 56-67.

[35] On the background to this shift, see R. Laudan, *From mineralogy to geology* (Chicago: University of Chicago Press, 1987), especially pp. 94-112, 138-179; on major

Beche that the purely disinterested collection of data and specimens, with no regard for theory, could advance science, the reality was that English geology by the late 1830s was already the domain of specialists. Local knowledge still had a role to play, but it was collected on the spot, by touring metropolitan gentlemanly geologists, acquired on their terms, not the observers'.[36]

This then was the intellectual rationale for a geological survey. Instead of "great numbers widely dispersed," there would have to be a small number of observers who covered every part of the country personally. The physical position of individual rock beds and the relation of successive strata to each other were qualities that inhered not in a specimen but in a site; they could not travel out of the field to be analyzed in a museum. Geological maps would thus take a long time to produce, but would be more meaningful because they were the result of a consistently applied vision. Some of the ideals expressed by reformers could be preserved: the value of minute and precisely-recorded detail; a map's ability to stand in for nature. Others goals would fall by the wayside: the chance for science to benefit from contributions by keen members of the public; and the concomitant moral benefit thus accrued. Even as he wrote *How to observe*, De la Beche

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developments in British stratigraphy in this period, see Rudwick, *Great Devonian controversy*; J. Secord, *Controversy in Victorian geology* (Princeton, NJ: Princeton University Press, 1986).

[36] In addition to the accounts by Rudwick and Secord, see also S. J. Knell, *The culture of English geology, 1815-1851* (Burlington, VT: Ashgate, 2000) on the role of private collectors. Fossils were the most common way that non-geologists "contributed" to science (and collecting them took a skill all its own); they are mentioned both by Herschel and in "Eyes and no eyes." Isolated specimens had taxonomic value, but their use in stratigraphy required records of their exact location down to feet and inches in a bed; this was the sort of thing that geologists had to observe for themselves, not obtain secondhand from collectors. For more on the largely-unwritten role of the technical men who worked for hire, mineral prospectors and civil engineers, see H. Torrens, *The practice of British geology, 1750-1850* (Burlington, VT: Ashgate, 2002).

was moving beyond the model of science it described: when the text was revised in the 1850s, it was re-titled *The geological observer*, contained much more technical detail, and was intended to "abridge the labours of those who may be desirous of entering upon the study of geology," in other words, not as casual passers-by but as dedicated specialists.[37] This was a far cry from the appeal to travellers and students to use their "time to the best advantage," merely by noting facts "which might otherwise pass unnoticed," that had been issued a scant fifteen years before.[38] By 1840, geological expertise had passed into the hands of those who worked in the field, and observations made *in situ* were beginning to pay new dividends in advancing knowledge and reconstructing the past.

2.3 The Origin of Coal, I: Knowledge *in situ*

By the mid-1830s, the production of geological knowledge had two requirements: it had to be based on personal fieldwork, as opposed to secondhand reports, however credible, and it also demanded an increasingly sophisticated ability to interpret the evidence one observed. Only the experienced specialist could make such judgments: where a coal miner or railroad engineer saw unexceptional phenomena, a geologist was one who could examine the same excavation and discover the key to a whole new understanding of a region's structure or a fundamental process. This characterization of the distribution of

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[37] H. T. De la Beche, *The geological observer* (London, 1851), p. vi. In this preface he claimed that geology had come far in recent years and that observations were now much more carefully made.

[38] De la Beche, *How to observe*, p. 5. See Secord, *Victorian sensation*, ch. 14, pp. 472-78, for the cultural context of this transition.

authority is nicely illustrated by some of William Logan's first geological work, which earned him scientific legitimacy and paved the way for his Canadian career.

Around the turn of the nineteenth century, it had begun to be generally accepted that coal was the transformed remains of plants, rather than simply another species of mineral. The next question, then, was where these plants had come from. In the 1820s and 30s, British geologists believed that coal plants and trees had grown on dry land, only to be swept away by occasional torrential floods and deposited under water, in lakes or estuaries, along shorelines, or farther out at sea.[39] This view, called the "drift" theory, is not surprising, because it mirrors the process by which many rocks were formed. Terrestrial material (sand, clay, silt) was eroded by the action of water, and settled out in even layers on the ocean floor. The drift theory was also an attractive model because Lyell and others had actually observed the ongoing accumulation of uprooted trees in the deltas of large rivers like the Mississippi.[40]

Around 1840, however, an alternative theory began to gather strength. A few botanists had previously suggested that *some* coal plants were preserved in the same place in which they had grown. Now, it appeared that *most* coal might have been formed "*in situ*." Instead of being washed away and deposited at sea, the ancient forests had

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[39] W. Coneybeare & W. Phillips, *Outline of the Geology of England and Wales* (London, 1822), "Of the coal measures," pp. 326-347. For a good summary of English beliefs at the beginning of the 1830s, see A. Sedgwick, "[Presidential] Address [1831]," PGSL 1 (1826-1833): 281-312; two years later, Roderick Murchison concluded a similar missive with the claim that "the most essential... of all our scientific wants is a perfect history of the coal fields," R. Murchison, "[Presidential] Address [1833]," PGSL 1 (1826-1833): 438-463, quoting p. 463.

[40] See, for example, J. Phillips, *Manual of geology: practical and theoretical* (London, 1855), pp. 210-220. See also A. Scott, "The legacy of Charles Lyell: advances in our knowledge of coal and coal-bearing strata," in D. Blundell & A. Scott, eds., *Lyell: the past is the key to the present* (London: Geological Society, 1998): 243-260. The idea of "drift" was also current in glacier theory.

lived, died, and been submerged without ever being uprooted. With repeated cycles of uplift and subsidence, the plant deposits built up slowly, layer after layer, not unlike modern peat bogs. William Logan was one of the most energetic exponents of this interpretation, and its place in the development of his career is an excellent illustration of his commitment to observing in the field. Indeed, he so successfully used his coal work as a base upon which to build a long and illustrious career that the contributions of other workers to the *in situ* growth theory have been all but forgotten.

Standard accounts of Logan's life, from the Victorian biography to more recent works, describe the proof of the *in situ* theory of the origin of coal as a highlight of his pre-Canadian career.[41] More specifically, though, it is also possible to see it as the moment at which the connection between personal field experience and the creation of broadly-applicable geological knowledge finally crystallized for Logan. Here, his formative experiences even before he went to South Wales are important. As a young man in Edinburgh, he would have been exposed to a public culture of geology that emphasized venturing out into the field.[42] Though his geological readings during the

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[41] B. J. Harrington, *Life of Sir William E. Logan, Kt.* (Montreal, 1883), ch. 5; M. Zaslow, *Reading the Rocks: The Story of the Geological Survey of Canada 1842-1972* (Ottawa, 1975), p. 38; S. Zeller, *Inventing Canada: Early Victorian Science and the Idea of a Transcontinental Nation* (Toronto, 1987), p. 43.

[42] This topic has benefited from several recent studies; see S. Hartley, "Appealing to nature: geology 'in the field' in late Enlightenment Scotland," in C. Withers and P. Wood, eds., *Science and medicine in the Scottish Enlightenment* (East Linton, UK: Tuckwell Press, 2002), 280-300; on closely related topics, see M. D. Eddy, "Scottish chemistry, classification and the early mineralogical career of the 'ingenious' Rev. Dr John Walker (1746 to 1779)," *British Journal for the History of Science* 35 (2002): 411-438; and D. Finnegan, "The work of ice: glacial theory and scientific culture in early Victorian Edinburgh," *British Journal for the History of Science* 37 (2004): 29-52. The classic study is R. Porter, *The making of geology: Earth science in Britain 1660-1815* (Cambridge: Cambridge University Press, 1977), which addresses both the role of

1820s are not known, he displayed an instinctive sympathy for the transformative power of a change of elevation, as shown by a letter written to his brother James in 1821 (that is, when he was 23 years old), describing the area around the Logan family home at Clarkstone, near Stirling: "walk a little distance and ascend any of the green knolls that are near, and you are repaid for your step by a prospect magnificent indeed"; the combination of "cloud-capt" mountains with their "blue and distant sublimity," "the wide waters of the Forth," and "the low, level and fat land" formed "as admirable a view as can be conceived or desired by the heart of man."[43] Throughout his early adulthood, Logan continued to be imbued with the spirit of lengthy excursions and keen observation, as his 1827 walking tour of the Scottish Highlands and ascent of Ben Nevis show. Again, much like young Master William in 'Eyes and No Eyes,' Logan was entranced on this excursion by the "most extensive prospect" available from "the highest land in Britain," as he looked out over the sixty-mile view to the Isle of Skye and the Atlantic.[44]

A decade later, it is instructive to see the changes that had occurred, both in Logan's interests and in the nature of observation. In 1836, he wrote to John Phillips, secretary of the recently-organized British Association for the Advancement of Science, with a modest request: "If the association will be so good as to supply me with the necessary Instruments for investigating the temperature of mines I shall be happy to register & report the results I may obtain in the neighbourhood of Swansea where I work

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Enlightenment-era travellers and the increased emphasis on utilitarian description and classification of rocks in Scottish (as opposed to English) geology.

[43] Logan to James Logan, 31 August 1821, LP/MUA; also quoted in Harrington, *Life of Logan*, p. 27.

[44] Quoted in Harrington, *Life of Logan*, p. 44. This is drawn from a lengthy travelogue apparently written to James Logan on 9 May 1828, however it is one of a number of items quoted by Harrington that are not present in the Logan Papers collection at McGill University Archives.

Coal mines myself & have an easy access to those of others."[45] By this time, Logan had moved from London to Swansea, and was daily engaged with copper smelting, an important and rapidly-expanding industry in coal-rich South Wales.[46] But it is worth noting that Logan also now embraced the principle of uniting quantitative observation (in this case, temperature) with geographic (or spatial) distribution, an ideal classically described as "Humboldtian."[47] The observer in the field was no longer a passing gentleman, content to imbibe wide vistas in one sweep, but a technical specialist, carefully tracking his progress underground to determine the relationship of temperature to depth, stopping to check his thermometer at regular intervals.

The 1830s were a key decade for Logan: Hugh Torrens has skilfully unearthed the connections Logan made with local coal miners and surveyors in South Wales after becoming a manager in 1831 at the Forrest Copper Works, located just north of Swansea, in which his uncle Hart Logan was a partner.[48] William Logan was an early member of

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[45] W. Logan to J. Phillips, 27 August 1836, John Phillips Papers, Oxford University Museum of Natural History. On the BAAS, see Morrell & Thackray, *Gentlemen of science*. See also J. Morrell, *John Phillips and the business of Victorian science* (Burlington, VT: Ashgate, 2005).

[46] E. Newell, "'Copperopolis': the rise and fall of the copper industry in the Swansea district, 1826-1930," *Business History* 32 (1990): 75-97; see also E. Newell, "Atmospheric pollution and the British copper industry, 1690-1920," *Technology and Culture* 38 (1997): 655-689.

[47] For the origin of this term, inspired by the Prussian naturalist-explorer Alexander von Humboldt, see S. F. Cannon, *Science in culture: the early Victorian period* (New York: Science History Publications, 1978); for a more recent appraisal, see M. Dettelbach, "Humboldtian science," in N. Jardine et al., eds., *Cultures of natural history* (Cambridge: Cambridge University Press, 1996), pp. 287-304. Compare De la Beche's plan for a network of observers to record the amplitude and direction of earthquake tremors.

[48] H. Torrens, "William Edmond Logan's geological apprenticeship in Britain 1831-1842," *Geoscience Canada* 26 (1999): 97-110. For the business and social context, see D. Bayliffe & J. Harding, *Starling Benson of Swansea* (Bridgend: D. Brown & Sons,

the Swansea Literary & Philosophical Institution, and the honorary geological curator of that body's successor society, the Royal Institution of South Wales.[49] The RISW admired Logan's innovative use of a measuring instrument, "termed (they believe) a Clynometer… capable of being made available to many purposes, & especially to our Mining District," and asked him to submit a description of it.[50] Logan was also responsible for communicating with the recently-established Museum of Economic Geology in London, expressing the hope that the RISW could play an invaluable role in collecting local specimens and practical facts for metropolitan use.[51] While this harkened back to the older notion of dividing the labour of observation between enlightened local residents and experts who might never see the place themselves, such ideas were the very sustenance of mid-nineteenth-century provincial scientific societies.[52]

1996), pp. 19-50, passim; D. Bayliffe, "William Logan and the Welsh connection," *Minerva: Journal of Swansea History* 9 (2001): 65-86.

[49] Logan donated many specimens to the collections and helped raise funds for the RISW's new building (1842), today the Swansea Museum. For the social function of such efforts, see L. Miskell, "The making of a new 'Welsh metropolis': science, leisure and industry in early nineteenth-century Swansea," *History* 88 (2003): 32-52. See also R. Rees, *Heroic science: Swansea and the Royal Institution of South Wales* (St Athan, Glamorgan: Wales Books / Glyndŵr Publishing, 2005).

[50] J. W. G. Gutch, 1 December 1838, Council Minutes, vol. 1 (July 1835-July 1846), RISW. A clinometer measures angles of slope and elevation; in this case, the dip of strata. Such data are crucial to inferring the geological structure of strata that lie beneath the observable surface, and hence to representing them on a geological map.

[51] 4 May 1839, Council Minutes, RISW; W. Logan and J. Gutch to H. De la Beche (copy), 18 May 1839, Council Minutes, RISW. For De la Beche's reply, see 20 May 1839, p. 84, Director-General's Entry Book, MPG I (1835-42), GSM 1/1, BGS.

[52] Classic works in this literature include I. Inkster & J. Morrell, eds., *Metropolis and province: science in British culture, 1780-1850* (Philadelphia: University of Pennsylvania Press, 1983); and D. Allen, *The naturalist in Britain* (Princeton, NJ: Princeton University Press, new ed., 1994).

A meticulous accountant by inclination and training, Logan soon found himself personally mapping the structure of the extensive coal fields of the region.[53] He is credited with making highly-detailed horizontal "sections" at six inches to the mile, recording surface observations of geology with more geographical accuracy than ever before.[54] In effect, he transformed a simple walk across the countryside into a minutely measured and plotted analysis. These efforts brought him into contact with Henry T. De la Beche in 1837, when the still-young Ordnance Geological Survey entered South Wales; in January of that year, Logan had become a Fellow of the Geological Society of London, and in September he exhibited his geologically-coloured Ordnance Survey map sheets at the meeting of the British Association for the Advancement of Science at Liverpool.[55] The question of the origin of coal was just the sort of "geohistorical, paleoenvironmental" problem that De la Beche was fascinated by, and the two men remained in frequent contact over the next few years.[56] De la Beche wanted to be able to reconstruct past environments, and discover the specific processes that had formed a various geological features; it seems likely that it was his influence that encouraged

[53] For brief mentions of Logan's work in his uncle's counting house, see Harrington, *Life of Logan*, pp. 12, 48. For an example of a grid-based quantification of coal veins in Logan's early geological work, see GSM 1/218, pp. 142-3 (probably ca. 1836-38).
[54] Bailey, *Geological Survey of Great Britain*, p. 33; see also Flett, *First hundred years*, pp. 39-45; and D. Bassett, "Wales and the geological map," *Amguedda: Bulletin of the National Museum of Wales* 3 (Winter 1969): 10-25, pp. 21-23.
[55] W. Logan, "On that part of the South Welsh coal basin which lies between the Vale of Neath and Carmarthen Bay," *British Association for the Advancement of Science Report* (Liverpool 1837), 83-85. Harrington, *Life of Logan*, p. 59; Torrens, "Logan's geological apprenticeship," pp. 105-107. See also Swansea *Cambrian*, 10 October 1837.
[56] For this description of De la Beche's theoretical interests, see Secord, "Geological Survey of Great Britain." For a calendar of most of Logan's letters to De la Beche, see T. Sharpe & P. J. McCartney, *The papers of H. T. De la Beche (1796-1855) in the National Museum of Wales* (Cardiff: National Museum of Wales, 1998), items 868-888.

Logan to make the leap from a practical miners' fact about coal beds to a theoretical generalization.[57]

What Logan already knew was that experienced colliers, whom he interviewed at every opportunity, had long recognized that a layer of clay was found underneath every seam of coal in South Wales. The name for this layer varied widely from place to place, but it was often called "gwely," "bottomstone," or "underclift."[58] At first, Logan seldom noted this stratum separately from its associated coal seams, except when it was valuable in its own right as "fireclay," used to make bricks for high-temperature applications. In April 1839, however, he started to pay more attention to these layers, in which he had just begun to notice what he called "root-like impressions."[59] Paleontology played little role in the coal fields, and so Logan was not equipped to interpret this finding right away.[60] Less than a year later, though, he was in London, speaking before the Geological Society for the first time, telling them that these roots, which he now identified as the plant fossil

[57] On this strand in the "English school" of geology, see Rupke, *Great chain of history*. For an older contrarian claim that geological science owed little to industrial development see R. Porter, "The Industrial Revolution and the rise of the science of geology," in M. Teich & R. Young, eds., *Changing perspectives in the history of science* (London: Heinemann, 1973), 320-343.
[58] GSM 1/218, W. E. Logan, "Notes and sections relating to the South Wales coalfield" (large bound volume),1836-42, BGS, passim. This volume contains entries, mostly undated or ca. 1838, which Logan copied over from his field notebooks. For closely related material, see De la Beche's own undated notebook, GSM 1/123 (ii), p. 14, BGS, which contains descriptions of a number of Logan's sections (e.g., pp. 15, 21, 31), some dated in 1840. It appears likely that De la Beche's notes on underclays and *Stigmaria* were inspired by Logan's guidance, but it impossible to determine the exact chronology of their individual conclusions from these documents alone.
[59] GSM 1/67 add., Logan field notes, book 4 (1838-39), BGS.
[60] However, compare Edward Mammatt's *A collection of geological facts and practical observations* (London: G. Lawford, 1834) written by an experienced coal field worker, which noted the presence of fire clays and plant fossils under many coal seams and speculated about possible explanations for their existence (pp. 72-74). Mammatt's work is sometimes acknowledged as an anticipation of Logan's theory; see in particular Torrens, "Logan's geological apprenticeship."

Stigmaria ficoides, were the remains of great masses of vegetation.[61] Vast forests had grown in the mud that was to become the "underclay," and had been turned into coal in the same spot in which they had been rooted. Contrary to the previous orthodoxy of drift, Logan argued that coal was assuredly formed *in situ*.

But Logan's paper, delivered in February of 1840, was not the first one that the Geological Society had heard on this topic. Two others challenging the drift theory had been read less than a year earlier. The first, by a young engineer named John Hawkshaw, reported on upright fossil trees found in a railway cutting near Manchester.[62] Such finds were crucial evidence because it was hard to believe that a torrential river could uproot a tree, carry it a great distance, and set it back down again in a life-like position; and it was impossible to imagine that this had happened, as in the Manchester case, to five trees in close proximity to each other. The second paper was by a well-known artist and philanthropist, J. T. Barber Beaumont. Having examined Hawkshaw's trees, Beaumont not only agreed with the younger man's interpretation, but advanced his own theory of how coal formation might have proceeded *in situ*.[63] In reviewing these contributions at the end of the year, the President of the Geological Society, William Buckland, cautioned against accepting their views unequivocally. He believed that there was a growing

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[61] W. Logan, "On the Character of the Beds of Clay lying immediately below the Coal Seams of South Wales," PGSL 3 (1840): 275-277; published in full in the *Transactions of the GSL* series 2, vol. 6 (1842): 491-497.
[62] J. Hawkshaw, "Description of five fossil trees found in the excavations for the Manchester and Bolton Railway," PGSL 3 (1839): 139-140. ODNB.
[63] J. Barber Beaumont, "On the origin of the vegetation of our coal fields and wealdens," PGSL 3 (1839): 152-153. ODNB.

amount of evidence to suggest that both methods of coal formation had operated, and that neither theory should be endorsed at the expense of the other.[64]

Interest in the topic continued to grow: a few weeks after Buckland reviewed the first two contributions, an entire meeting was given over to three more papers on the formation of coal. This was the occasion on which Logan presented his discovery, and far from being alone, he was in the middle of an active discussion.[65] The other two papers were by Hawkshaw, again, and John Eddowes Bowman, a senior Manchester naturalist.[66] Hawkshaw and Bowman both added further observations about the fossil trees, and the superior plausibility of the *in situ* theory. Logan, we know, introduced the novel phenomenon of roots permeating the layer of clay under each seam of coal. When William Buckland came to make his second annual review of progress a year later, his attitude was markedly changed. "I have never before seen such convincing proofs of this hypothesis as are furnished by the facts advanced by Mr. Hawkshaw, Mr. Bowman, and Mr. Logan, taken in connexion with one another."[67] The credit appeared to be shared between all three contributors equally. Buckland then went to considerable lengths to revise his own theory of coal formation to take this new mechanism into account, and give it the prominence it deserved.

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[64] W. Buckland, "[Presidential] Address [1840]," PGSL 3 (1840): 210-267.

[65] Although it does not discuss this case, a valuable source on the contemporary GSL is J. Thackray, *To see the fellows fight: eyewitness accounts of meetings of the Geological Society of London and its Club, 1822-1868* (Stanford in the Vale, Oxfordshire: British Society for the History of Science, 2003).

[66] J. Hawkshaw, "Further observations on the fossil trees found on the Manchester and Bolton Railway," PGSL 3 (1840): 269-270; J. Bowman, "On the characters of the fossil trees lately discovered near Manchester… and on the formation of coal by means of gradual subsidence," PGSL 3 (1840): 270-275. (ODNB.)

[67] W. Buckland, "[Presidential] Address [1841]," PGSL 3 (1841): 469-540; quotation from p. 489.

Several months after delivering his paper at the Geological Society, Logan left Britain for North America. He traveled mainly for business reasons, but took the opportunity to visit coal fields whenever he could.[68] Having successfully demonstrated the connection between plant fossils, underclays, and coal in South Wales, he now sought to generalize his phenomenon to coal formations everywhere. It was on this trip that he first met Charles Lyell, who expressed much interest in his work.[69] Logan was thrilled to find the characteristic *Stigmaria* fossils under virtually every coal seam in both Pennsylvania and Nova Scotia. In October of 1841, after more than a year in North America, he wrote triumphantly of his observations, "My fact, therefore, I now consider established beyond controversy, and I shall tell the Geological Society the same before the winter is over."[70]

Meanwhile, back in Swansea, William Buckland had given a stirring address on the origin of coal at the Royal Institution of South Wales.[71] Significantly, this was to be instrumental in paving the way for Logan's move to Canada. Logan had been the geological curator of the Swansea museum, and the audience was naturally pleased to hear of his significant accomplishments. On this occasion, Buckland chose not to emphasize the multiple contributors to the *in situ* theory, as he had in his recent address to the Geological Society. Instead, he gave virtually all of the credit to Logan, saying that Logan's discovery had transformed many fixed opinions on the topic, including Buckland's own. The other observers who had presented their findings were mentioned

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[68] Logan's 1840-41 Journal of his travels in Canada and the U.S. is in TPL.
[69] Logan, 1840-41 Journal, pp. 254-261.
[70] W. Logan to J. Logan, 2 October 1841, LP/MUA.
[71] W. Buckland, Swansea *Cambrian*, 5 June 1841. See RISW archives, item 203, Minute Book 1844-1852, Swansea Museum, Wales.

seemingly as an afterthought; their efforts had only "greatly tended to confirm Mr. Logan's theory."

Buckland's address to the Royal Institution of South Wales turned out to be rather useful for Logan, because it was reprinted later that year in the Montreal *Gazette*, after Logan had returned from North America to Britain. The accompanying editorial urged Logan's suitability to become the inaugural director of the Canadian geological survey.[72] The most pressing question of the day was whether or not coal existed in Canada, and no one could have been more qualified to answer it than William Logan. He had presented a coalfield map in unprecedented detail at Liverpool, and he now had certified expertise in theorizing the formation of coal deposits. After he returned to Britain in October 1841, Logan presented his observations on the Pennsylvania and Nova Scotia coal fields to the Geological Society.[73] Shortly thereafter, in the spring of 1842, he was officially appointed to head the newly-instituted geological survey of Canada, on the advice of De la Beche, Buckland, Roderick Murchison, and Adam Sedgwick.[74]

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[72] Montreal *Gazette*, 9 November 1841. This topic is well covered in Zeller, *Inventing Canada*.

[73] W. Logan, "On the Coal Fields of Pennsylvania and Nova Scotia," PGSL 3 (1841): 707.

[74] R. I. Murchison to G. W. Hope, 5 April 1842, f. 557, CO 42/500; H. T. De la Beche to Hope, 5 April 1842, f. 559, CO 42/500; W. Buckland to Hope, 5 April 1842, f. 49, CO 42/501; A. Sedgwick to Hope, 8 April 1842, f. 393, CO 42/502, PRO. See also the printed pamphlet, *Testimonials in favour of Mr. W. E. Logan, in regard to his appointment as Provincial Geologist for Canada* (Montreal: Lovell and Gibson, 1846). Zeller, *Inventing Canada*, covers the political and legislative origins of the Survey thoroughly.

2.4 The Origin of Coal, II: The Formation of History

Although Logan seems to have had little trouble advancing his career, it doesn't follow that Buckland's version of Logan's contribution to the coal question was unanimously accepted. Alternatives appeared on all sides. The Philadelphia geologist, H. B. Holl, complained immediately to De la Beche that Logan had not acknowledged the oral and published sources of his information on the structure of the Pennsylvania coal basins, and suggested that Logan's observations on *Stigmaria* in underclays were not original either:

> In a recent paper to the Geol. Society by Mr. Logan that gentleman most certainly has forgotten to state the sources of much of his information [on Pennsylvania] … for he derived his knowledge of those facts from oral communications with some of the members of our Corps. … he with great care surpresses any allusion to these documents [the published reports]. He claims likewise to be the first to notice the Stigmaria in the underclay of coal veins but I believe Mr. Mammatt mentioned the fact in his work some 6 or 8 years ago.[75]

Logan had recorded meeting the eminent American geologist brothers, William Barton Rogers and Henry Darwin Rogers, in Philadelphia in early September, and obtaining copies of the Pennsylvania geological reports.[76]

Even within the Geological Society of London, not all shared Buckland and De la Beche's enthusiasm for *in situ* coal formation. Roderick Murchison, the next President,

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[75] H. Buchanan Holl to H. De la Beche, 29 May 1842, item 695, DBP. On Mammatt, see note above.
[76] Logan, 4 September 1841, p. 377, Journal 1840-41, TPL. On H. D. Rogers's own research and his geological survey of Pennsylvania, see P. Gerstner, *Henry Darwin Rogers*, and S. P. Adams, *Old Dominion, industrial Commonwealth*, ch. 4.

used his annual addresses in 1842 and 1843 to urge caution, reminding "young geologists" not to be fooled into believing that the theory was of "general application" simply because it had "recently been rendered fashionable."[77] Murchison pointed out that, based on his own travels in Russia, there were still many, many coal deposits to which Logan's model did not apply. In some cases, for example, the plants were mixed up with marine fossils, meaning that the strata had been laid down at sea, rather than inland. Another possibility was that *Stigmaria* plants had simply grown in the estuaries where drifted vegetable matter collected.

Moreover, the Geological Society was not the only forum for the discussion of such issues. The most prominent alternative was the British Association for the Advancement of Science, which met each year in a different provincial city. In 1842, the BA met in Manchester, bringing us to the second branch of the story. The origin of coal was a popular topic, dealt with in at least three papers in the Geological Section that year.[78] Especially notable was the one by E. W. Binney, a Manchester lawyer and amateur paleontologist. In his paper, Binney referred to practical miners' knowledge that coal seams rest on clays containing *Stigmaria*. He deduced that the plants had lived in quiet conditions, and that the vegetation that became coal had certainly grown in situ. Yet he did not even mention Logan's name in this discussion, despite following Logan's earlier argument rather closely.

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[77] R. Murchison, "Presidential Address [1842]," PGSL 3 (1842): 637-687; "[Presidential] Address [1843]," PGSL 4 (1843): 65-151, passim.
[78] J. Phillips, "On the microscopic structure of coal," *BAAS Report* 1842: 47; W. Williamson, "On the origin of coal," *BAAS Report* 1842: 48; E. Binney, "On the great Lancashire coal field," *BAAS Report* 1842: 49-51. On Binney, see ODNB.

Binney's approach was not an isolated aberration. The following year, 1843, John Hawkshaw read a paper at the Manchester Geological Society on "the present state of geological inquiry as to the origin of coal." It was subsequently published in the *Annals of Philosophical Discovery and Monthly Reporter of the Progress of Practical Science.*[79] Hawkshaw's lengthy review did not mention Logan once. Yet Hawkshaw had been in the same room as Logan three years earlier, when they read their first papers at the Geological Society of London. The work of J. E. Bowman, the third contributor to that earlier meeting, was mentioned frequently by Hawkshaw, however, as were his several articles on the origin of coal published in the *Transactions* of the Manchester Geological Society.[80] On *Stigmaria* fossils in underclays, Hawkshaw cited Binney's paper at the British Association. Evidently, it was all too easy for the Mancunian naturalists to leave Logan out of the historical record.[81]

Thus, alternative histories were certainly available. It was not at all certain that Logan would achieve the status of sole discoverer of the origin of coal.[82] However, the particular ways in which Logan achieved renown in his field certainly contributed to the reinforcement of his early theoretical accomplishment. After his displays of Canadian economic minerals at the Great Exhibition of 1851 and at the Paris Exposition of 1855 were so widely praised, his old friends at the Geological Society of London wasted no

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[79] J. Hawkshaw, "Some observations on the present state of geological inquiry as to the origin of coal," *Annals of Philosophical Discovery* 1 (1843): 249-266.
[80] E.g., J. Bowman, "On the origin of coal; and the geological conditions under which it was produced," *Transactions of the Manchester Geological Society* 1 (1841): 90-111.
[81] For context, see R. H. Kargon, *Science in Victorian Manchester* (Baltimore: Johns Hopkins University Press, 1977).
[82] It might be argued that the other contributors did not make their careers as field geologists, as Logan did, and for this reason alone were less likely to be remembered by the geological community.

time in reaffirming their connection with the new hero. He was inducted into the Royal Society in 1851, and after he was made a Chevalier of the French Legion of Honour and knighted by Queen Victoria. Relatively few scientists received formal honours like a knighthood in this period. Logan's own knighthood probably reflected more his contributions to empire, by encouraging colonial economic development, than to pure science. But that was no reason for scientists, both in Europe and North America, not to be proud of him. The Geological Society, under the presidency of Roderick Murchison, wanted to show that they had played a major role in Logan's career. Within weeks, Logan had been awarded the their highest honour, the Wollaston Medal.

The year was now 1856. A decade and a half had passed since Logan's paper on *Stigmaria* in underclays, and since he had confidently announced that his "fact" was "established." It so happened, however, that the President of the Geological Society now, charged with making the address on the award of the Wollaston Medal, was W. J. Hamilton. Back in 1840, Hamilton had been one of the secretaries of the Society (the other was Charles Darwin). So even as Hamilton announced that Logan was receiving this medal as a result of his recent triumphs, he was careful to remind his audience that Logan had also been "the first to remark that … there must be some essential and necessary connexion between the existence of Stigmaria and the production of coal."[83]

Of Logan's original supporters, De la Beche had recently died, and Buckland had long since retired. But Murchison, who had always been wary of the *in situ* theory, now

[83] W. Hamilton, "Award of the Wollaston Medal," *Quarterly Journal of the Geological Society of London* 12 (1856): xxi-xxvi. Murchison accepted the medal and responded on Logan's behalf, using the occasion to proselytize for his Silurian system in North America. His desire that these remarks be distributed along with news of the award was apparently successful, judging from the Canadian newspaper accounts preserved in Logan's scrapbook, TPL.

saw in Logan an invaluable ally in his quest to cover the world with his Silurian system of stratigraphic nomenclature.[84] He proclaimed that Logan had discovered a "natural history constant which has enabled us to read off the true history of the greater number of coal-fields."[85] The varying reasons for which geologists were interested in Logan's work on the origin of coal illustrates well the interconnectedness of the disparate aspects of his career. His first geological activities, mapping the South Wales coal basin, led to theorizing about ancient environments, which led to explorations abroad to generalize his observations. His work on the Geological Survey of Canada was primarily mapping and locating economic minerals, but this brought him back across the Atlantic to international exhibitions, which led to revived interest in his views on the origin of coal.

Hamilton's account, unlike Buckland's earlier addresses, mentions no other participants at all, an omission which fosters the view that Logan was a lone theorist.[86] Ultimately, this episode reminds us that the historical record is a conscious and deliberate creation, albeit with a healthy dose of contingency mixed in. Logan's work was endorsed by De la Beche, Buckland, and Murchison, because it coincided with their own research agendas. And yet, it is quite possible to see how Logan's discovery of the *in situ* origin of coal could just as easily have been left out of the canon of facts that define him.[87]

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[84] R. Murchison, *The Silurian system* (London, 1839). The fourth edition (1867) was dedicated to Logan, who had assisted Murchison by applying the Silurian name widely in Canada; see Conclusion. See R. Stafford, *Scientist of empire*, and J. Secord, "King of Siluria."

[85] R. Murchison, in Hamilton, "Award," xxiv.

[86] See Logan's own account of his role in acknowledging the Wollaston Medal, etc. Toronto *Globe*, clipping, April 1856, Logan scrapbook, TPL.

[87] A later history by W. C. Williamson gave Logan credit along with Binney, Hawkshaw, and the rest, but placed Logan's early work inexplicably in Cornwall. W. Williamson, "Coals and coal plants: a lecture delivered in the City Hall, Glasgow…" (London and Glasgow, 1876), cf. p. 11. The British survey geologist A. C. Ramsay also commented

2.5 How to Observe, Redux

By the mid-nineteenth century, Britain's geology was among the best-understood in the world, having seen several generations of work by mining engineers, gentlemanly amateurs, and most recently professional geologists. The work of the Geological Survey was thus a revision and elaboration of existing knowledge in most places, employing the Ordnance Survey's trigonometric base maps and drawing on previous geological maps and memoirs.[88] What, however, of Britain's vast imperial possessions? With territory that was barely explored, let alone scientifically understood, the need for an organized system of observation, analysis, and publication was that much greater in colonies like Canada and Australia.[89] Thus, I now want to begin to examine the question of how Logan brought British surveying practices into the service of colonial development in beginning his geological survey of Canada.

First and most important were points of personal contact between Logan and De la Beche. Living in Swansea, Logan had pursued geology as a hobby in the 1830s, rendering the structure of the South Wales coal fields in unprecedented detail on Ordnance Survey maps. Logan exhibited his work at the meeting of the British

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on coal field structure and formation, saying that Logan first observed that *Stigmariae* were "constantly present" in Welsh underclays, and "he connected this circumstance with the occurrence of the overlying coal", but also said that Mr. Binney, of Manchester, first proved *Stigmariae* to be roots of *Sigillariae*. See A. Ramsay, *A descriptive catalogue of the rock specimens in the Museum of Practical Geology* (London: Eyre and Spottiswoode for HMSO, 1858), p. 59.

88 Scotland was an exception. For the Survey's work there, see D. Oldroyd, *The Highlands controversy*, (Chicago: University of Chicago Press, 1990). There is surprisingly little work on geological mapping itself; for Ireland, see G. Herries Davies, *Sheets of many colours* (Dublin: Royal Dublin Society, 1983); see also chapters below.

89 For the "inventory sciences" of geophysics, geology, and botany, see Zeller, *Inventing Canada*.

Association for the Advancement of Science in 1837, and later offered to donate all of his maps and sections to the Geological Survey, which De la Beche gratefully accepted.[90] In the summer of 1840, Logan showed De la Beche a general phenomenon he had discovered about the stratigraphy and origin of coal deposits, which, being a topic of current theoretical interest, had cemented his scientific reputation in London.[91] Of the four eminent geologists who recommended Logan for the Canadian survey, De la Beche's letter was the longest and most explicit, testifying that he had personally verified the "minuteness and accuracy" of Logan's maps and sections by going over the same ground.[92] In other words, Logan's personal credibility as an observer and mapper was to be the bridge between the programmes of British and Canadian geological surveying. During the first years of the Geological Survey of Canada, Logan and De la Beche corresponded about the idea of close cooperation between the two projects.[93] While circumstances made this impractical, the point is that they considered their surveys to be fundamentally similar, despite the many differences between the two environments.

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[90] H. T. de la Beche, "On the formation of the rocks of South Wales and South Western England," *Memoirs of the Geological Survey of Great Britain* 1 (1846): 1-296; Flett, *First hundred years*. On first leaving for Canada, Logan told De la Beche "If I should sink in the Atlantic I must trust to you for posthumous fame. I shall put you down in my will, which I have not made yet, for all my sections & c."; 1 August 1840, DBP. De la Beche's reply of 3 August 1840 is in LP/MUA, along with a more detailed discussion of his plans for Logan's Welsh work the following year (De la Beche to Logan, 30 November 1841, LP/MUA).

[91] W. E. Logan, Field notebook 4, April 1839, GSM 1/67; H. T. De la Beche, Notebook, GSM 1/123 (ii), pp. 14-18, BGS. The paper read before the Geological Society in February 1840 was Logan, "On the character of beds of clay."

[92] H. T. De la Beche to G. W. Hope, 4 April 1842, CO 42/500, PRO. Reprinted in Harrington, pp. 126-8. One might add that it was above all his mapping that Logan's referees so admired, and so in that sense the coal theory was secondary – yet Logan seemed to care more about the latter, pursuing it eagerly in North America while the coal maps languished in South Wales, to De la Beche's dismay.

[93] Formal examples are Logan to De la Beche, 24 April 1843, DBP; De la Beche to Logan, 25 April 1843, LP; both printed in Harrington, pp. 136-41.

When Logan first arrived in Canada, he circulated a printed questionnaire about the local distribution of rocks and minerals that attracted some sixty responses from a wide range of towns in both Canada East and West: at first glance, this was just the sort of public participation that the *How to observe* books contemplated. Logan posed twenty questions under four general headings, targeting above all the occurrence of limestone, sandstone, and gypsum (plaster) beds; fossils; iron, lead, and copper ores; coal; and "great masses of rock."[94] He also asked if it would be possible for respondents to send in specimens. But of course the answers were notable primarily for their diversity, both in how they understood the purpose of the questionnaire and in how they responded to it.

Some readers thought they were being asked to conduct a geological survey themselves; others avowed that they were incapable of responding. Most, instead of providing the quantitative and qualitative details Logan sought, merely transmitted second-hand anecdotes about where coal and other valuable minerals were sure to be found, if only the funds were available to dig for them. Reports abounded of flammable black or sulphurous rocks, and indications of coal were prefaced with qualifiers such as "I am informed that," "It is thought that," "I have heard it asserted that," or "I have been told by a respectable person, an eye witness that…"[95] Others seemed preoccupied with secret Indian knowledge of copper deposits. A few responses might have been satisfactorily detailed, but these were too "widely dispersed" to be of much use in the

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[94] The questionnaire was reproduced in the preamble to Logan's first reports; RP 1843.
[95] "Geological Survey of the Province of Canada: Responses to Sir William Logan's Survey of 1842," Logan Manuscripts, William Logan Collection, Earth Sciences Information Centre, Natural Resources Canada, Ottawa. See, for example, the form submitted by E. Pooler of St. Sylvester. However, it should be noted that Logan also received reports of oil springs in southwestern Ontario that were not errors or exaggerations; see for example the submission from Alex Vidal of Sarnia.

absence of the "great numbers" that the philosophy of observation by the many required. And against these, even those that were individually useful, Logan had to count the inevitable diatribes against the idea of geological surveys in general.[96] In the end, this right kind of "survey" was sharply limited in what it could produce, and that was ultimately not much more than Logan could accomplish through personal visits and informal social networks. As a tool, the "how to observe" manifesto of the 1830s was all promise and no practicality.

Logan's experience in this respect tallies with similar examples of contemporary attempts to bypass the need for firsthand field experience. To take one, in his geological survey of Virginia during in the 1830s, William B. Rogers made extensive use of field assistants, following the advice and example of his brother Henry, who directed the surveys of New Jersey and Pennsylvania. Yet in Virginia, which offered forbidding terrain and difficulties of access quite similar to what Logan would face in Canada, William Rogers found that he was heavily dissatisfied with the assistants' work, criticizing their omissions due to inexperience and describing their work as "months of … blind labor."[97] And indeed, Logan himself, in turning over his South Wales research notes to the Geological Survey of Great Britain in 1842, had already noted:

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[96] For criticism, see for example the report of Hamilton Merritt of St. Catherines; on the other hand, Logan received a very positive response from the provincial land surveyor John McNaughton in Bytown, who said that "no part of Canada West furnishes a more ample & interesting field for the researches of the geologist and the mineralogist than the Ottawa [River] and its tributaries," and indeed McNaughton later accompanied Logan on his 1845 expedition up the Ottawa River.

[97] M. Aldritch and A. Leviton, "William Barton Rogers and the Virginia Geological Survey, 1835-1842," in J. Corgan, ed., *The geological sciences in the antebellum South* (University, AL: University of Alabama Press, 1982), 83-104; see pp. 92-94, quoting p. 94. See also B. Cohen, "Surveying nature: environmental dimensions of Virginia's first scientific survey, 1835-1842," *Environmental History* 11 (2006): 37-69. Although

> There are in the possession of Mr. Edmond 4 or 5 small pocket books in which a multitude of facts are stated in respect various [sic] Coal seams. But they are registered in such a confused manner that I fear nobody but myself can make them out. However they are all at your command. Your difficulty would be to distinguish what is correct & what is erroneous. Many things were put down as hearsay to be inquired into. The amount of nonsense I have been told is very considerable.[98]

In later years, Logan expressed the central importance of information gathered in place even more bluntly, appealing to an ideal system of inscriptions to ensure that there would be a perfect correspondence between maps, specimens, and physical territory: "Without its exact geographical position a specimen is of little or no use geologically, and in regard to a collection of these I would not trust the memory of even the person who gathered them, unless he could shew marks on his map and corresponding marks on his specimens, made at the time they were broken from the parent rock."[99]

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excellent in many respects for its attention to the technical details and logistical obstacles implicated in state surveying, in terms of scientific work Cohen's article focuses largely on the laboratory analysis of mineral samples; thus, despite an ample dose of analysis, the field as the primary site of geological observation remains resolutely "blackboxed."

[98] Logan to H. T. De la Beche, 4 August 1842, DBP. The books referred to appear to be nos. 1-4 in GSM 1/67 add., BGS. Many names of Logan's local informants are given; see also Torrens, "Logan's geological apprenticeship." In transcribing some information given him by a Mr. Morgan in June 1837, Logan added the comment, "NB Mr. Morgan it must be remembered, never hesitates to permit his invention to supply the deficiencies of his memory." (Logan, "Notes and sections," p. 72, GSM 1/218, BGS.)

[99] Logan testimony, Question 77, in J. Langton, "Report of Select Committee," Appendix L, JLAPC 1854-5. This question and the next specifically addressed the issue of voluntary assistance on the Survey, but Logan's responses were restricted to polite acknowledgements and statements about future possibilities, apart from a few comments about a projected scheme involving samples submitted by provincial land surveyors, to which the above quotation refers.

The upshot, then, was that reliable (by definition) geological observations could not simply flow from the field into the centre; rather, the central observer had to physically travel in the field, covering all the ground firsthand, in order to produce the desired results. Only an experienced geologist could decide, through field surveys, and then chemical and paleontological work in the lab, the correct age of a formation, and hence the colour it should be given on the map. But when a user, a landowner or an MP or a civil servant, looked at the map, he saw not that labour but the land itself; in this sense William Logan's maps would offer a vantage like that of Master William in "Eyes and no eyes." In fact, a geological map is arguably the ultimate thematic map because its theme is the physical composition of the earth itself: as a representation, the map offers a detailed, convenient picture of nature that is even better than the real thing. We could thus argue that a map embodies three kinds of transparency: the map is transparent, functioning as a direct proxy for the surface of the land; the intellectual, technical, and social work that produces a designation like "Devonian" or "Silurian" is transparent, allowing the viewer to believe that such knowledge, represent by a colour on the map, is as much a natural part of the rocks as their own colour; and finally the surface of the earth itself is transparent, allowing one to imagine it really has been cut away like the skin of an apple or an orange, as De la Beche had explained, and forget that much of the geology shown on a map is what he called "ideal," that is, merely skilfully inferred. What was going to be essential, then, was how the geologist conducted himself in the field, and how he was able to make sense of what he observed. These topics form the basis of the next two chapters.

CHAPTER 3

Senses of Place

It was important that Logan had built his scientific reputation on studies of coal. This mineral was of no small consequence to industrial Britain and its empire. Because it had not yet been confirmed whether or not coal existed within the colony of Canada, it is fair to say that the quest for it was one of the main reasons why the Provincial Legislature approved the funds for a geological survey in 1841. Logan's suitability for the evaluation of colonial mineral resources was in fact so obvious that, before the Canadian survey was finalized, De la Beche was part of a scheme to petition Sir Robert Peel, the Prime Minister, to employ Logan on behalf of the British government in Nova Scotia, where coal reserves necessary to supply the burgeoning transatlantic steamship traffic were already being developed. "[I]t has struck me as most desirable," De la Beche wrote, "that the opportunity of an examination of Nova Scotia, especially of its coal field, by such a man as Logan, should not be lost, and that it is of great importance that he should turn his attention to that land, instead of Canada, for the present."[1] While Logan was of course not employed in Nova Scotia, that colony still would have a role to play in his plans for establishing Canadian geology.[2]

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[1] De la Beche to Buckland, 14 March 1842, Robert Peel papers, British Library Add. MS 40504, vol. 324. See also, Buckland to Peel, 16 March 1842, and Buckland to Peel, 18 March 1842.

[2] All the mineral rights in Nova Scotia had already been assigned to a monopoly interest; see D. Samson, "Industrial colonization: the colonial context of the General Mining Association, Nova Scotia, 1825-1842," *Acadiensis* 29.1 (Autumn 1999): 3-28.

3.1 Joggins: 'Such a section as never was put together before'

William Logan had visited Nova Scotia as a geologist at least twice before, but in 1843 he came with a new purpose and with a new destination in mind. In particular, he wanted to examine a stretch of cliffs along the Bay of Fundy coast near a village called Joggins (or sometimes "the Joggins"). In 1840 and 1841, Logan had spent short periods of time in Nova Scotia en route to and from Britain, merely to further his personal geological experience and seek additional evidence for his views on the formation of coal.[3] In 1843, however, he came to Nova Scotia as the newly-appointed geological surveyor of the Province of Canada, a separate colony altogether. Notably, Nova Scotia had what Canada so far seemed to lack, that most crucial geological commodity, coal. On his previous trip there in 1841, Logan had been impressed by the coal fields in production near Pictou, and he now wished to inspect what promised to be an unprecedented exposure of Carboniferous strata, in the Joggins area. If he was going to settle the question of whether coal existed in Canada, it would be necessary to make a thorough study of the position of the known coal-bearing strata elsewhere in British North America.[4] Moreover, Charles Lyell, the most eminent British geologist, had recently

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[3] Martin Rudwick has suggested that such travel to new locales was an important element in the development of a nineteenth-century geologist's perceptions. M. Rudwick, "Geological travel and theoretical innovation: the role of 'liminal' experience," *Social Studies of Science* 26 (1996): 143-159.

[4] Logan to De la Beche, 31 May 1843, DBP. Scientifically, the best chance for coal in Canada was in Gaspé. There was little possibility that coal existed in Canada west of Québec City, because of that region's geological similarity to the state of New York, already surveyed.

conducted field investigations in Nova Scotia, and recommended the area, suggesting that any work by Logan on Nova Scotian geology would be of substantial interest to him.[5]

In his first annual report of progress, Logan explained his rationale for having begun the survey of Canada outside of Canada: "... particularly to ascertain the north limit of the coal deposit, ha[s] been the object of my labours during the past season. With a view the better to prepare myself for the investigation, it appeared to me expedient, [on his arrival at Halifax from Great Britain at the end of May,] that I should journey by land across Nova Scotia and New Brunswick to Canada, and in doing so take the opportunity of visiting the celebrated display of coal measures at the Joggins on the Bay of Fundy, with the hope that it might prove serviceable to me in studying the more northern parts of the deposit."[6] Logan had made his reputation in Britain as a mapper of coal fields and as an important contributor to recent reversal geological debates about how the great coal deposits of the Carboniferous had been formed.[7] Canadians had wanted a geological survey because their colony, unaccountably, still lacked proven coal. Logan was ideal for the job because he was a coal expert, but in order to deploy that expertise he had to start where the coal was, and that was not in Canada. From a practical point of view, workable coal deposits existed at several points on mainland Nova Scotia and Cape Breton Island. But to a scientist, by far the preeminent locale for the examination of

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[5] Lyell to Logan, 13 April 1843; Lyell to Logan, 27 April 1843, LP/MUA. C. Lyell, *Travels in North America, Canada, and Nova Scotia, with geological observations*, vol. 2 (London, 1855, second edition). See also L. Wilson, *Lyell in America: Transatlantic geology, 1841-1853* (Baltimore, 1998), pp. 117-128; and R. Dott, "Lyell in America: his lectures, field work, and mutual influences, 1841-1853," *Earth Sciences History* 15 (1996): 101-140.
[6] RP 1843, p. 14.
[7] N. Rupke, *The great chain of history : William Buckland and the English school of geology (1814-1849)* (Oxford: Clarendon Press, 1983), pp. 194-199.

Carboniferous strata was the magnificently-exposed section at Joggins that ran unbroken for miles and miles.

Although Joggins had been known to local geologists like Abraham Gesner for some years, it had only come to the attention of the elite British geological community in the spring of 1843. Charles Lyell had visited Nova Scotia the previous year, and had been taken to Joggins by Gesner, where he was impressed by the linear extent of the deposits and above all by the large fossil trees embedded in them, lying exactly perpendicular to the tilted strata, perfectly preserved in the upright position in which they had originally grown.[8] Lyell, as the most influential advocate of using present-day phenomena to explain the geological past, had once been a leading proponent of the 'drift' theory of coal formation, believing that the vast mats of flood-swept trees that clogged certain river deltas were the modern model for coal fields, characterized as they were by horizontally-extensive deposits of remarkably uniform thickness. But recent discoveries of upright fossil trees, along with Logan's observation that root-like plant fossils (*Stigmaria*) could always be found in the clay beds underlying every seam of coal, marked the beginning of a change in the theoretical consensus from about 1841.[9] The old drift theory increasingly gave way to the new '*in situ*' theory, and in Lyell's description of Joggins at the Geological Society of London in April 1843 he portrayed

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[8] Wilson, *Lyell in America.*

[9] W. Logan, "On the character of the beds of clay lying immediately below the coal seams of South Wales, and on the occurrence of coal boulders in the Pennant Grit of that district," *Transactions of the Geological Society of London* series 2, 6 (1842): 491-497; W. Buckland, "[Presidential] Address [1840]," PGSL 3 (1840): 210-267; W. Buckland, "[Presidential] Address [1841]," PGSL 3 (1841): 469-540. But cf. R. Murchison, "[Presidential] Address [1842]," PGSL 3 (1842): 637-687; R. Murchison, "[Presidential] Address [1843]," PGSL 4 (1843): 65-151.

this locality as a classic example of the development of coal fields by the successive growth of forests in place over a long period of time.[10]

William Logan was not present on that evening, only a few weeks before he left for Canada, but he received a letter the next day from Lyell, who said: "I was disappointed at not seeing you at the Geological Society yesterday, ... especially as my allusion to the Stigmaria underclays [i.e., Logan's *in situ* theory] and to yourself brought on a discussion." Lyell also invited Logan to call on him in person so they could go over a map of Nova Scotia together.[11] This coincided well with Logan's plans, for in his preliminary report to the Canadian government the year before he had specifically mentioned Lyell as a potentially valuable advisor on the geological relationships of the British North American colonies, writing:

> I hope also to obtain the suggestions of Mr. Lyell, whose recent visit to the New World having given him an opportunity of closely studying the results arrived at in the Geological Surveys appointed by their Legislatures in various States of the American Union, and of subsequently comparing these with the labours of Dr. Gesner and others in New Brunswick and Nova Scotia, will give his opinions a peculiar value in regard to the structure of both extremes of the Province, while these opinions will still

[10] C. Lyell, "On the upright Fossil-trees found at different levels in the Coal strata of Cumberland, Nova Scotia." PGSL 4 (1843): 176-178.
[11] Lyell to Logan, 27 April 1843, LP/MUA.

> further be enhanced by the personal inspection he bestowed on several points in Canada itself during his rapid transit through it."[12]

This indicates that Logan believed that, despite colonial boundaries, it was important to consider the geology of Canada in conjunction with that of its maritime neighbours.

It appears, then, that Logan's decision to start his inaugural Canadian surveying season in Nova Scotia was, if anything, overdetermined. A study of Joggins could help answer the colonial economic question of whether coal existed in Canada; it would also advance theoretical knowledge about mechanisms of coal-field formation, which was particularly important to Logan personally, since it was part of the basis for his career. The site was of recent interest to the British geological community, and it also provided a necessary starting point in reasonably well-known territory from which to venture out, across New Brunswick, to the much less explored Gaspé peninsula of eastern Canada, where there was still a (slight) possibility that coal might be found. Logan could hardly do otherwise than start at Joggins. When he arrived in Halifax at the end of May, he wrote to Henry De la Beche, director of the British Geological Survey, "I landed yesterday, and tomorrow morning I start northward for the district of Gaspé in Canada. I go by land, intending to walk a good part of the distance.... I shall pay a visit to the Joggins, where Lyell saw the vertical trees, and I shall endeavour to determine the thickness of the whole deposit there."[13] Logan clearly recognized what a successful study of the strata at Joggins could do for him, and he had high hopes for his results. Just how high is evident from the work he did when he got there.

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[12] Logan, "Preliminary Report" (in RP 1843), p. 2. State geologists were often quite unhappy to see their work assimilated by Lyell, however; see R. Silliman, "The Hamlet affair: Charles Lyell and the North Americans," *Isis* 86 (1995): 541-561.
[13] Logan to De la Beche, 31 May 1843, DBP.

In the mid-nineteenth century, Nova Scotia literally was an intermediate place between Britain and Canada. Transatlantic steamers came to Halifax, and from there one travelled onwards to Quebec and Montreal by local means, over land and by smaller boats that plied the coast and St Lawrence river. After purchasing some supplies in Halifax for his summer's work, Logan spent the next five days making his way overland to Minudie, near Joggins.[14] Then, he spent five full days logging some 14,570 vertical feet (over 4.3 km) of strata by pacing along the beach and noting each individual layer, whether it was several feet thick or only a few inches. Horizontal distances along the ground were measured simply by his own paces, and later converted to vertical thickness by taking into account the observed "dip" of the formation at each point.[15] Where the strata were inclined more steeply, he could record more layers over a given distance or period of time; thus, he logged about 3700 feet on the first day, 4700 feet on the second, and 3900 feet on third. As the dip of the rocks became shallower, however, his progress slowed: 1360 feet on the fourth day, and only 868 feet on the fifth.[16] After recording more than one thousand, five hundred individual beds, Logan finally admitted to himself: "The measures having assumed a westerly course, and coinciding with the coast, while the dip is reduced to a very small angle, it is likely that a farther investigation would

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[14] See map in M. Rygel & B. Shipley, "'Such a section as never was put together before': Logan, Dawson, Lyell, and mid-nineteenth-century measurements of the Joggins section," *Atlantic Geology* 41 (2005): 87-102.
[15] Logan, "Joggins, Bay of Fundy, Nova Scotia" [1842-1843], Field Notebook 1962, vol. 158, RG 45, LAC.
[16] Logan's work at Joggins is reconstructed and analyzed at greater length in Rygel & Shipley, "'Such a section as never was put together before'."

require a longer walk than I can afford."[17] In five days, Logan had constructed a section of remarkable scope and detail, covering nearly twice as much ground as any subsequent worker, despite the fact that Joggins remains one of the best-known geological sites in eastern Canada.

In his efforts to construct Joggins as an intermediate site between Britain and Canada, Logan was successful in at least one respect. He diligently applied the same technique of detailed logging that had brought him acclaim in mapping the South Wales coal fields in the mid-1830s, and in doing so generated a vast quantity of specific data: the strata were described quantitatively, in terms of thickness and inclination, and qualitatively, in terms of rock type, colour, physical characteristics, and fossil contents.[18] One published version of the finished section took up "64 pages of 45 lines to a page + the type not large."[19] However, the question that remained was what one could do with such a product: was Logan's massive Joggins section a new exemplar of colonial science, destined to set the course for his geological surveying in Canada, or was it really a case of personal extremism that lay outside the bounds of any practical utility? The answer would hinge on whether Logan's ambitious plans for extracting the maximum value from his section were feasible. These plans were complicated because their realization was not in Logan's hands, but in those of others, on the other side of the Atlantic.

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[17] Logan, "Chaleur Bay – Bay of Fundy" [1843], Field Notebook 2606, vol. 158, RG 45, LAC; entry for 10 June 1843. See throughout this book for a detailed account of Logan's work at Joggins.
[18] H. Torrens, "William Edmond Logan's geological apprenticeship in Britain 1831-1842," *Geoscience Canada* 26 (1999): 97-110.
[19] Logan to Lyell, 10 January 1853, Charles Lyell Papers, Gen. 113/3500-01, Edinburgh University Library.

Soon after leaving Nova Scotia, indeed before even reaching Gaspé, Logan wrote again to De la Beche (his mentor), boasting: "I think I mentioned to you I intended to visit the Joggins. I did so + spent a week in putting together such a section as never was put together before. I measured + made a written description of every bed … occurring in 10 miles, reduced to a line directly across the strata." More crucially, though, he alluded to the many different types of fossils he had observed, collected, and carefully packaged to send back to Britain for examination, by means of "around about way forwarded through hands, on the coast of the Bay of Fundy, more accustomed to the plough than the ~~clinometer~~ geologists hammer."[20] De la Beche did in fact receive this box of Joggins fossils and send it on to John Phillips, the British Geological Survey's paleontologist, who had previously struggled to find time to examine specimens Logan had collected from around Montreal in earlier years.[21] Hearing nothing of his precious Joggins collection, Logan grew increasingly worried, opening a letter to De la Beche the following year with: "How comes it that you have never written to me? Did you get my letter from Bathurst [New Brunswick]? & did you get the Box of Specimens sent you from Nova Scotia?"[22] And seven months later, he wrote: "I am anxious to know whether you got my Joggins section & what you think of it…. A year & a half ago I sent you or

[20] Logan to De la Beche, 2 July 1843, John Phillips Papers, Oxford University Museum of Natural History. Logan may have changed the word for literary effect; it indicates that he was thinking of himself both as a geologist and a surveyor.
[21] Phillips to De la Beche, 10 August 1843, DBP. Logan had visited York, presumably to see Phillips, in March 1843 before his return to Canada; see Logan, "Joggins, Bay of Fundy, Nova Scotia" [1842-1843], entry for 17 March 1843. For illustrations of Canadian fossils "examined by John Phillips, York," see the opening pages of Logan, "Gaspé, Quebec" [1844], FN 1965, RG 45, LAC. On John Phillips generally, who was probably Britain's busiest geologist in the mid-nineteenth century, see S. Knell, *The culture of English geology, 1815-1851* (Burlington, VT: Ashgate, 2000); and J. Morrell, *John Phillips and the business of Victorian science* (Burlington, VT: Ashgate, 2005).
[22] Logan to De la Beche, 20 April 1844, DBP.

rather put on the way of being forwarded to you a box of specimens from the Joggins; did this ever reach you? I have heard nothing of it since, not withstanding I have asked you three times to say[;] fish jaws and fish scales associated with stigmariae were among the specimens."[23] Logan's problem was that, by contemporary standards, a detailed stratigraphical section accompanied by expert identification of the fossils found in each bed would constitute a valuable contribution to both to geological theory and to knowledge of global geohistory; without paleontology, though, his section was in peril of being nothing more than a list of rocks. Logan was an expert self-taught field surveyor, but of the indoor science of fossils he knew much less. And, even had this not been the case, he no longer had the Joggins fossils to refer to, for they were stranded somewhere in the British Survey's offices in London.

Logan's Joggins section was an awkward hybrid product: a survey conducted for the Canadian government, yet of a place not in Canada; a section compiled according to British standards for a British audience by a British scientist, yet with no connection to British fossils. It would be important to publish this enormous undertaking in the right venue, so that it would reach its proper audience, but who was that audience, and what was the venue? Logan believed that his analysis of the Joggins coal field was highly relevant to the work currently being undertaken by the British Geological Survey on the coal regions of South Wales, of which he had been the pioneer. Accordingly, he hoped that he could find a way to bring the lengthy Joggins section to the attention of British scientists. His first thought, right after leaving Joggins, was that he might "possibly put it

[23] Logan to De la Beche, 11 Nov 1844, DBP.

before the Geological Society" because it was "accurate work + ought not to be lost."[24] However, after he had reduced his observations of paces and dip to vertical thickness a year later, creating a finished manuscript that filled "54 pages of foolscap closely written," he admitted of the Geological Society that "I am aware they would not print it. There is not poetry enough about it for their pages." Instead, he told De la Beche, "I mean to get the document published somehow or other, & I should be glad if you would allude to it publicly.... If I were in Britain & had a little leisure I think I could make geological capital of this section, but I do not feel inclined to bottle it up for future private use when it is probably it may prove of general service. Facts are the great desiderata at present in geology."[25] Where, then, could Logan publish his extremely lengthy section, full of greatly desired facts and yet devoid of 'poetry'?

As it happened, the director of the Geological Survey of Canada was obliged to make annual reports to the colonial government, to be published in the appendices of the Legislative Assembly's sessional papers.[26] Logan disliked this genre intensely, saying "I wish these annual reports were at the devil.... in my mind they have a very awkward appearance." However, faced with little else positive to report after his first year (since he was not yet ready to draw conclusions from his Canadian explorations in Gaspé), Logan took this opportunity to match his Joggins section (a hard-to-classify scientific product) with this restrictive form of publication. "In these compulsory reports it is my intention to give facts & no theory," he told De la Beche. "I have introduced my Joggins section in an appendix as a fact. If you had sent me the names of the shells, fish scales &

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[24] Logan to De la Beche, 2 July 1843, Phillips Papers.
[25] Logan to De la Beche, 20 April 1844, DBP.
[26] See RP (series). Logan also had offprints of these reports produced for private distribution; see chapter 5 below.

jaw & plants which I forwarded to you all numbered, my section would have had a most learned air."[27] Instead of legitimating his observations through the tool of international paleontological correlation, Logan could only illustrate the published section with his own sketches, based on his personal experience at Joggins.[28]

Logan's Joggins section was described above as a hybrid, suggesting that it spans two categories, functioning both as a colonial economic document that could help locate coal in Canada and as a philosophical study of the formation and structure of coal fields generally that could illuminate the work of geologists everywhere. Clearly, this was Logan's hope, as seen in the numerous and plaintive references he made to it in his letters to the British Geological Surveyor director, De la Beche. But one could also argue that the Joggins section is better described not as a hybrid but a monster. Instead of spanning two categories, it fell between them. Instead of functioning in two ways, it did neither. None of this is to diminish Logan's extraordinary personal accomplishment, either at the time, or as a permanent, now well-recognized, contribution to the geology of Atlantic Canada. But it does help to explain how the Joggins section was able to remain obscure for so long, proved difficult even for Logan's close colleagues to find, and continued to elude working geologists throughout the twentieth century (who relied on a 1908 republication that did nothing to clarify the section's origins).[29] In 1852, Charles Lyell wrote to Logan asking for a copy of the Joggins section, which he had not been able to locate anywhere. Lyell was planning to revisit the area in collaboration with John William Dawson, a leading young Nova Scotian geologist, who also had no idea of where

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[27] Logan to De la Beche, 27 December 1845, DBP.
[28] See Rygel & Shipley, "'Such a section as never was put together before'."
[29] H. S. Poole, "A section of Carboniferous rocks in Cumberland County," *Proceedings and Transactions of the Nova Scotian Institute of Science* 11 (1908): 417-550.

to find the Joggins section in print; they both doubted it had ever been published at all.[30] Logan explained not only that it had been printed in his first report to the Canadian government, but that he had sent copies to the Geological Society, where it had been mentioned by the President, to De la Beche's Museum of Practical Geology, where it had been bound with his other reports, and indeed even to Lyell himself, inducing Logan to note, "I dare say you will find it in your library."[31] Part of the problem, no doubt, was that legislative appendices were an unlikely place to look for lengthy geological publications. But Lyell and Dawson were probably also making another, very understandable, mistake – they did not expect to find Logan's work at a site in the colony of Nova Scotia published in the official government reports of his geological survey of the colony of Canada. (Lyell and Dawson located it by asking personally, but presumably many other potential readers did not.[32]) Once again, Logan's hopes for the broad relevance and interest of his Joggins section were being held up by its frustratingly anomalous status.

The role of 'place' in the production of scientific knowledge has, of course, received much recent attention in science studies.[33] The story of Logan's efforts at Joggins provides a useful window on how colonial fieldwork is closely tied up with the

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[30] Lyell to Logan, 16 December 1852, LP/MUA. S. Sheets-Pyenson, *John William Dawson: faith, hope, and science* (Montreal & Kingston: McGill-Queen's University Press, 1996); Wilson, *Lyell in America.*
[31] Logan to Lyell, 10 January 1853, Lyell Papers.
[32] See, however, L. Horner, "Anniversary address of the President [26 February 1846]." *Quarterly Journal of the Geological Society of London*, 2 (1846): 145-221.
[33] D. Livingstone, *Putting science in its place* (Chicago: University of Chicago Press, 2003) is a good overview. Recent studies that have particularly influenced my reading include D. G. Burnett, *Masters of all they surveyed* (Chicago: University of Chicago Press, 2000); and B. Latour, "Circulating reference: sampling the soil in the Amazon forest," chap. 2 in *Pandora's hope: essays on the reality of science studies* (Cambridge, MA: Harvard University Press, 1999), pp. 24-79.

processes of circulating knowledge. In particular, it is an instructive case of what happens when knowledge does *not* circulate, or circulates imperfectly.[34] As Logan explained to Lyell in 1853, his misplaced reliance on the British paleontologists had meant that, "when the section was printed I had not the fossils by me to try my own poor skill upon them, + I was under the necessity of referring to them as I had noted them in my field book, which to my mortification detracted of course greatly from the interest of the section."[35] The whole affair bothered Logan so much that he took matters into his own hands, bringing the boxes of Joggins fossils back from London to Montreal himself in 1851, and now (in 1853) sending them back to Lyell in London in the hopes that he might look at them. Lyell replied that he did not have time to do so, but would bring the fossils back to America with him in the summer of 1853 and send them on to Dawson, "for I understood you to desire to make the specimens useful + Mr Dawson will I am sure refer as carefully to your labours as I should have done."[36] The Joggins specimens thus would have traced a torturous path back and forth between London and British North America, crossing the Atlantic four times just to be examined in Nova Scotia, the colony from which they had originally been collected.

What this shows is that making colonial fieldwork 'work' was no trivial task. The presumed ability of knowledge to circulate meant that conducting British field science in the colonies could promise both local benefits and an increase in international knowledge, but there was no guarantee this promise would be fulfilled. Given Nova Scotia's physical, and even potentially epistemological, intermediacy between Canada

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[34] See J. Secord, "Knowledge in transit," *Isis* 95 (2004): 654-672.
[35] Logan to Lyell, 10 January 1853, Lyell Papers.
[36] Lyell to Logan, 18 May 1853, LP/MUA.

and Britain, Logan faced an irresistible temptation to undertake a highly detailed study of the coal formations there. The enormous amount of labour he expended, both in logging mile after mile of outcrop along the coast and later in revising thousands of observations and calculations into an achingly long manuscript, reveals just how important he thought the Joggins section could be. But, unable to be connected decisively either to his previous work in Britain or to his subsequent work in colonial Canada (where coal did not exist), it caused him as much grief as joy in the following years. In fact, Logan learned his lesson after Joggins and collaborated primarily with U.S. paleontologists, relating Canadian geology to the stratigraphic systems developed by American state geological surveyors, thus utilizing a more successful form of circulating knowledge.[37] The gap between the ideal and the reality of circulating knowledge shows that such issues were indeed central to the development of successful forms of colonial field science in the mid-nineteenth century.

3.2 Expanding the Field of Vision

This, then, is the context in which Logan came to Canada as a field geologist in 1843. In most respects, he was not inexperienced. He was fluent in British surveying and mapping practices, and intimately familiar with the structure of coal deposits. He had, in fact, spent parts of the previous three years touring British North America and the northeastern United States, meeting professional geologists, reading their reports, and visiting some of the most important geological sites.[38] In March 1842, he practiced chemical analysis

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[37] S. Zeller, *Inventing Canada* (Toronto: University of Toronto Press, 1987).
[38] W. E. Logan, "Canada and the United States," 1840-41 Journal, TPL.

techniques on some of the Canadian rock specimens he had gathered.[39] And in his official visit later that summer to Kingston (then serving as the Canadian capital) Logan had gathered existing maps and whatever other preparatory documents he could find, as well as apprising himself further of the work of U.S. state surveys. He also waited for the opening of the Legislative session in September, ostensibly to take advantage of the fact that "so many persons of intelligence might bring contributions from different and distinct localities, would afford a valuable opportunity for concentrating the floating knowledge bearing upon a subject."[40] Logan still had not, however, ventured into the Canadian bush itself, and attempted to bring order to unruly nature, to see geological patterns where none had been before. This was to be a major objective of the rest of his career. In the summer of 1843, he was only just beginning to undertake this task.

While the institutional history of the Geological Survey of Canada and its many scientific and cultural accomplishments have been well described,[41] much less attention has been paid to how the Survey operated at the microscopic level: how geologists worked in the field, and how these experiences shaped their results. While these are questions that arise from general issues in the history of science (with its attention to material cultures and practices, and to places of knowledge), I believe that they are also central to Canadian history.[42]

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[39] Tests for chromate of iron, sulphates, manganese, and others are recorded in Logan, "Lab book, England" [1842], Field Notebook 1960, vol. 158, RG 45, LAC.
[40] Logan, "Preliminary Report," in RP 1843; see p. W-3; see also the information and encounters recorded in Logan, "Marmora, Petite Nation River, Montreal to Kingston" [1842], FN 1961, vol. 158, RG 45, LAC.
[41] Most notably by M. Zaslow, *Reading the rocks* (Toronto: Macmillan, 1975); and Zeller, *Inventing Canada.*
[42] For reviews of fieldwork in historiography, see Livingstone, *Putting science in its place*; D. Oldroyd, *The Highlands controversy: constructing geological knowledge*

It was exactly in developing a new way of interpreting the landscape that colonial geologists like Logan were able to make such an impact with their projects. Ultimately, the achievements for which the Geological Survey of Canada received the most recognition in the mid-nineteenth century – the award-winning exhibits at international expositions, the comprehensive monographs, and the stunning maps – can all be traced back to work in the field: work that was always situated in specific social, cultural, and environmental contexts. Much of earliest work of the Survey, in the first few years of its existence, hinged on learning how to negotiate these contexts. One does not, after all, stumble over bare geological facts in the woods, or along the coast. Significant work, both physical and epistemological, must be done to establish the location, identity, and *meaning* of rocks in scientific terms. This work allowed geologists to translate successfully their field experiences into recognizable, authoritative products: reports, stratigraphical sections, and maps.[43] A close look at how this process took place lets us understand not only how geologists worked, but also the world in which they worked.

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through fieldwork in nineteenth-century Britain (Chicago: University of Chicago Press, 1990); and J. Camerini, "Remains of the day: early Victorians in the field," in B. Lightman, ed., *Victorian science in context* (Chicago: University of Chicago Press, 1997), 354-377, especially the list of references therein. Comparative Canadian cases of exploration and mapping include: C. Franks, "Ontario's North in 1837: David Thompson's explorations of the Muskoka and Madawaska Rivers," *Queen's Quarterly* 92 (1985): 348-363; D. Jenish, *Epic wanderer: David Thompson and the mapping of the Canadian west* (Lincoln, NE: University of Nebraska Press, 2003); and R. Ruggles, *A country so interesting: the Hudson's Bay Company and two centuries of mapping, 1670-1870* (Montreal & Kingston: McGill-Queen's University Press, 1991). A very useful survey of pre-Confederation field science is S. Zeller, "Nature's Gullivers and Crusoes: the scientific exploration of British North America, 1800-1870," in J. Allen, ed., *North American exploration, volume 3: A continent comprehended* (Lincoln, NE: University of Nebraska Press, 1997), 190-243.

[43] For the crucial role of field experience in U.S. stratigraphic debates, see J. Newell, "American geologists and their geology: the formation of the American geological

It is for these reasons that Logan's first field seasons are so interesting, despite the fact that their formal outcome was relatively modest.[44] The excellent documentary record of Logan's work in 1843 makes it possible to recapture his first encounter with the Canadian environment, and his first attempts to turn this experience into geological knowledge. His mission could be stated simply: to explore the colony's territory, from Gaspé to the Great Lakes, and to describe the mineral resources he found therein. It was not so obvious, however, just how this task was to be accomplished. He was soon reminded that natural phenomena are not unambiguous; the first step in making observations is learning how to see.

Early in the expedition, coming downriver into the village of Gaspé, Logan and his companion John Stevens were informed by their native guide, John Basque, that seals were common in the area. Logan recorded in his journal

> When we got a little below the marshes Basque said he saw a lot of them ahead. Neither Stevens nor I could make them out. But we saw what we concurred to be a small island in the direction Basque pointed. As we approached this we suddenly heard a tremendous splashing as if a whale was floundering near us. It alarmed me a little, for I did not consider a bark canoe quite a safe retreat from a whack of his tail. When the splashing had ceased the island had disappeared. It was nothing more than

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community, 1780-1865," Ph.D. thesis, University of Wisconsin-Madison, 1993, especially pp.10-14; and on the use of maps and diagrams, chapter 4 therein.

[44] See chapters below; much of Logan's Gaspé work was revisited for the GSC by John Richardson in the 1860s.

> a collection of some 20 or 30 seals which had been lying on a bank just level with the water and their bodies above it had formed the island.[45]

Logan, Stevens, and Basque had all looked at the same natural phenomenon, but had seen very different things. Where Logan, new to the region, saw first an island, then a whale, John Basque recognized familiar animals exhibiting a common behaviour. Before he could become a successful Canadian field scientist, then, William Logan had to learn what it was to practice science in the field in Canada. He had to develop a geological way of seeing the environment that drew on, yet remained distinct from, local knowledge. In part relying wholly on the locally resident population, and in part defining himself in opposition to them, he had to find ways to make scientific observations in places where they had never been made before.

From Joggins, Logan had sought to extend his perceived triumph into Canada by covering the distance between them in the most gradual possible way. He travelled across the surface of New Brunswick, stopping several times along the way, and observing the continuity of Carboniferous formations.[46] Ultimately, however, he had to break this connection with the land: when he reached Bathurst, Logan reported, "I have not yet reached my own territory, but I am in sight of it. Bai de chaleur [sic], about 30 miles wide separates me from it, and its high lands are plainly discernible on the other side."[47]

Logan's crossing of the water between New Brunswick and Canada represents more than just a move from one political jurisdiction to another. It also embodies the

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[45] W. E. Logan, 15 July 1843, Gaspé 1843 Journal, NLW.
[46] Logan, "1843 Report." He stopped in Dorchester, Richibucto, Miramichi, and Bathurst.
[47] Logan to De la Beche, 2 July 1843, Phillips Papers.

transition from known to unknown terrain. The allure of 'terra incognita' to colonial surveyors explains why Logan was keen to make the Canadian landscape his own.[48] Gaspé was an attractive starting point for several reasons: in addition to holding out the most promise of coal, it was also believed to be geologically more complex than western Canada, to which Logan's assistant Alexander Murray had been assigned.[49] It was a convenient point to begin a survey, since it formed the eastern extremity of Canadian territory. And, as we have just seen, this last feature also meant that Gaspé was closest to the geologically more familiar world of Nova Scotia, and thus ultimately to Britain itself.

However, beginning in Gaspé also posed problems. To start with, there was no convenient way to see the peninsula. The region was of little interest to the provincial government, seen as resource-poor and demographically and economically stagnant. Local industry was overwhelming dominated by cod-fishing and drying, which in turn were controlled by just a few firms who paid the fishers only in truck.[50] Due to the lack of investment in infrastructure, interior transportation by road was virtually non-existent. While travel by boat suited the inhabitants well enough, it was plainly insufficient for making detailed measurements of rock formations. Logan realized that he would have to travel independently and spend many nights away from settled areas. His plan, he announced to the government, was "to proceed around the coast with a canoe and an

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[48] See Burnett, *Masters of all they surveyed*; although this study is not directly related to geology, a number of Burnett's arguments apply equally to Logan's case. Both cases are set in the 1840s, and both shed light on the somewhat diffuse relationship between London-based science and the conditions of research 'on the ground' in British colonies.
[49] Alexander Murray (1810-1884, DCB), whose family had personal connections with Logan's, had been trained by De la Beche on the British Geological Survey. See A. Murray to H. T. De la Beche, 19 April 1843, DBP.
[50] See R. Ommer, *From outpost to outport: a structural analysis of the Jersey-Gaspé cod fishery, 1767-1886* (Montreal & Kingston: McGill-Queen's University Press, 1991); D. Lee, *The Robins in Gaspé, 1766 to 1825* (Markham, ON: Fitzhenry & Whiteside, 1984).

Indian to carry my instruments." In addition, he had hired at his own expense John Stevens, son of a Bathurst mine owner, whom Logan confidently described as "[k]nowing something of mineral exploration, having a dash of the necessary enthusiasm, and being accustomed to rough it in the woods, able to handle an axe, manage a canoe, and fit up a *camp*, as they call it."[51]

Selecting the right "Indian" (Logan's term) took an equal amount of care. In the town of Douglas, Logan made inquiries that reflected his main concerns. "John Basque at Gaspé is an honest, sober and trustworthy Indian, and an expert man in a canoe," Logan recorded in his field notebook. "Petit Louis," on the other hand, could "manage well, but he is disposed to intemperance." "Grand Louis," his brother, was apparently better. Finally, Peter Ignace was also "a good Indian to manage a canoe .... He is sober, but not so good as Basque."[52] Not surprisingly, it was John Basque who got the job.

Logan, Stevens, and Basque were now underway – but what were they to do? Once they were out of the town, away from settled areas (such as they were), in the woods or in the canoe, how could Logan ensure that his ability to see the world as a British geologist would not gradually erode?

One of Logan's core strategies was to preserve his existing habits and geological practice as far as possible. Given the common scientific precept that reliable

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[51] Logan to R. W. Rawson, 10 July 1843. Quoted in Harrington, *Life of Logan*, 144-146. Emphasis in original. It is interesting to note that one of Harrington's index entries for Gaspé describes it as "*terra incognita*" (426).

[52] W. Logan, "Gaspé, Québec" [1843], Field Notebook 1964, vol. 177, RG 45, LAC; entry for 8 July 1843. For comparison, see D. G. Burnett, "'It is impossible to make a step without the Indians': nineteenth-century geographical exploration and the Amerindians of British Guiana," *Ethnohistory* 49 (2002): 3-40. On the Mi'kmaq people of Atlantic Canada, see V. Miller, "The Micmac: a maritime woodland group," in R. B. Morrison & C. R. Wilson, eds., *Native peoples: the Canadian experience*, 2nd edition (Toronto: McClelland & Stewart, 1995), 347-375.

observations could only be made by a disciplined observer, it is entirely typical to find Logan making routine notes on the hour at which he arose each day, and the temperature at that time, as a form of self-discipline.[53] The prevailing contemporary philosophy was nicely articulated by the leading Edinburgh natural philosopher and noted field scientist James Forbes (with whose work on glaciers Logan was well familiar):

> to carry a memorandum book ... in which notes, and observations, and slight sketches of every description are made on the spot, and in the exact order in which they occur.... They are then extended, as far as possible, every evening, with pen and ink, in a suitable book, in the form of a journal – from which, finally, they may be extracted and modified for any ultimate purpose.[54]

While Logan at first could hardly resist the temptation to describe camp life in romantic terms, he found it impossible to keep more prosaic concerns from intruding. On their first night in the bush, the challenges of self-sufficiency became uncomfortably clear to this scientific gentleman. In his journal, he reflected:

> While Basque was preparing the frying pan by boiling some water in it to get the rust off, he said we were in want of a dish cloth. Such is forgotten; and such being the case, he takes a hand full of leaves from the *white* tree and makes a dish cloth of them. But the want of a dish cloth puts me in mind that we have no towels, and the want of towels reminds me that we

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[53] Such observations appear in both Logan's journal and his field notebook. For background, see J. Golinski, "The care of the self and masculine birth of science," *History of Science* 40 (2002): 125-145.

[54] J. Forbes, *Travels through the Alps of Savoy... with observations on the phenomena of glaciers* (Edinburgh, 1843), pp. 5-6.

> have no soap. Shaving will therefore be out of the question for some time. ... A man must have his thoughts about him when he takes to house keeping in the woods.[55]

While field geologists in both Britain and North America commonly stayed away from home overnight, at inns, farmhouses or with people who had taken an interest in their work, such accommodations were not always available in Gaspé. On his first night in the woods, it was obvious that Logan had not fully thought through the implications of being self-reliant. In reality, though, Logan had to keep up far more than domestic conveniences. He also had to keep up the ability to make valid scientific observations, by managing the material context in which he worked.

For geological surveying itself, the need for planning and careful supervision was paramount. Specialized instruments like a surveyor's protractor and a prismatic compass were essential to make accurate determinations of the position and extent of exposed rock formations. Because geological surveying is the task of building up a three-dimensional picture of what lies beneath the surface, based on observations made in essentially two-dimensional space, on the surface, it is critical that angles and distances be measured as precisely as possible.[56] Two factors made this practice harder for Logan to maintain in Gaspé than it had been in Britain, during his experience in South Wales.

First, the overriding reality of the Geological Survey of Canada was that were no topographical base maps from which to start. Unlike their counterparts on the British Geological Survey, Canadian geologists' work was not merely colouring a pre-existing, carefully constructed, large-scale map. In Gaspé, Logan had only Captain Henry

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[55] Logan, 1843 Journal, entry for 13 July 1843.
[56] For background, see A. Maltman, *Geological maps* (New York: Wiley, 1998).

Bayfield's naval survey chart of the coastline to work with: helpful for navigation, place names, and major coastal features, but scarcely adequate as a representation of the surface of the land, onto which geological observations could be written.[57] This did not stop Logan from compiling tens of thousands of feet of geological sections, but it did mean that the question of where exactly these data were to be placed would have to be left for future years.[58] The prospect of a carefully laid-out network of trigonometrically-surveyed triangles, such as the British attempted to impose on their colonial holdings in India, was in the distant future.[59]

Second, in Gaspé, it was much more difficult to maintain the capacity to make scientifically-valid observations. Instruments could fail, get broken, or become lost, and without them, and the ability to replace or repair them, it was difficult to produce results that would be valued by the professional community. Five days after setting out on their expedition, life in the bush had already taken its toll. Somewhere along the way, Logan had lost a protractor, and he recorded that "[t]oday I broke the agate of one of my prismatic compasses. I have another protractor and another compass, but I must be careful of them."[60] Maintaining one's scientific composure, then, took constant

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[57] A contemporary of Logan, Bayfield was an equally zealous hydrographical surveyor who mapped much of the Great Lakes and St. Lawrence for the British Admiralty. See R. McKenzie, *Admiral Henry Wolsey Bayfield* (Ottawa: Fisheries and Marine Service, 1976). See also Zaslow, *Reading the rocks*, p. 43, for comments on surveying practice.
[58] It was not until 1855 that the GSC published any map showing Gaspé, and that was at 150 miles to the inch. Logan's larger-scale map of Canada (25 miles to the inch), was not published until 1869; P. von Bitter, "Sir William Logan's geological maps of Canada," *Map Collector* 68 (1994): 12-18.
[59] On India, see for example Edney, *Mapping an empire*. Canada did not have a federal trigonometric survey until the end of the nineteenth century.
[60] Logan, 1843 Journal, entry for 18 July 1843. It is recorded that a dial-compass lost by Logan near Little Gaspé was ploughed up by a farmer in 1915. See J. Clarke, *James Hall of Albany, Geologist and Paleontologist, 1811-1898* (Albany, 1923), p. 302.

vigilance. This is a prime example of the kind of self-discipline that colonial fieldwork required.

Just as important as the ability to gather geological data was the power to bring it out of the field safely, where it could be analyzed and written up in the proper format during the winter. Great exertions of physical labour in the field had value only if they led to inscriptions in Logan's little red notebook in which all observations were written down. Incredibly, Logan managed to lose this precious field notebook not once but twice in his first week in Canada. On the first occasion, Stevens found it fairly readily. The second time, though, it was lost overnight, causing Logan to reflect on the serious consequences of his lapse:

> Again I have lost my book and this time I have been obliged to return to the tent disconsolate without it. I shall put all hands to search for it tomorrow, for I shall die of a broken heart if it is not found. All the work I have done since I commenced is noted in it; and I shall be obliged to do it over again if the book is not recovered. A fortnight will thus be lost, and I doubt whether the work will be so well done the second time. Besides I shall get into disgrace for a supposed want of diligence, while God knows I have nearly done myself up with my exertions.[61]

This time, John Basque found the notebook, carefully retracing Logan's steps from the point where he had last used it. 'Misplacing' thus became a general theme of Logan's

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[61] Logan, 1843 Journal, entry for 20 July 1843 [sic]. In fact, according to the field notebook, this should be 21 July, a Friday. It is interesting to note that, in more than one place, Logan's journal and notebook do not agree on the date corresponding to a given day of the week, suggesting that, in addition to instruments and his notebook, Logan's difficulties even extended to the misplacing of time itself.

field experience, and tends to suggest that his mapping efforts were constantly at risk of being undermined by his difficulties in maintaining stable observational circumstances.[62]

Besides written observations, there was a second product of surveying work that was crucial in establishing its validity in metropolitan contexts: specimens of rocks and fossils. By the early 1840s, fossils were particularly central to the science of stratigraphy, because they were the primary means by which rocks of different types and in different regions could be correlated with each other.[63] Paleontology was to be the main tool for the determination of the age of Canadian rocks relative to those of Britain and the United States. However, as was the case with detailed mapping, paleontology required skills and resources that the Geological Survey of Canada lacked in 1843.[64]

If the problem with the notebook was that it was too small to hold on to, the problem with large and numerous pieces of stone was just the opposite. Logan recorded packing some sixty boxes of samples, with some pieces weighing hundreds of pounds. Since these were collected in widely varying locations, they needed to be left with trustworthy local residents, to be forwarded by ship to Québec, and eventually to Logan's

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[62] It may be worth noting that Logan's Gaspé journal itself was begun on the circumstance of its predecessor being misplaced. The very first line reads, "Having left my journal at Isle Percé by mistake I must begin a new one" (entry for 13 July 1843); the book referred to is Logan, "Chaleur Bay – Bay of Fundy" [1843], Field Notebook 2606, vol. 158, RG 45, LAC.

[63] The best account of the process by which this came to be true is Rudwick, *Great Devonian controversy*.

[64] Cf. Logan's efforts to get John Phillips to examine his Canadian fossils; see also R. Cleevely, "John W. Salter, Sir William Logan, and Elkanah Billings: a brief British involvement in the first Decade of 'Canadian Organic Remains' (1859)," *Earth Sciences History* 12 (1993): 142-159.

headquarters (his brother's warehouse) in Montreal.[65] In this way, Logan made use not only of existing patterns of settlement and transportation on the Gaspé peninsula, but also of communication networks in what was in many ways still a frontier society.[66]

The challenges of working in this social environment are illustrated by Logan's troubles with his hammer. Essential tools for geological exploration, hammers (unlike specialized optical instruments) can readily be manufactured and repaired by competent blacksmiths. When Logan lost his hammer at the end of September, he assumed that he would be able to obtain a new one. In the end, it took less time and effort to find the lost hammer than to find a willing blacksmith. The next day, however, Logan managed to snap the head off his hammer, ruining it completely, and making a smith's services imperative. John Stevens was dispatched to nearby Port Daniel, where there was said to be a blacksmith, whom Logan sincerely hoped would not be found to have "gone *afishing*." Indeed, Logan wanted to "take the opportunity to get another hammer made for there is plenty of need for hammers here."

Unfortunately, Stevens found that the blacksmith had already left Port Daniel for Paspebiac. He left the hammer behind for the blacksmith's return, with instructions that "it was to be returned tomorrow by the foreman of the ship builders, who lives at Port Daniel, and goes home every Saturday night." In the meantime, Logan and John Basque, who had proven an excellent fossil hunter, were left "surrounded by fossils without a

[65] The names of these individuals, and the instructions given to them, were carefully recorded in Logan's Gaspé field notebook. E.g., entries for 13 July, 10 August, 26 August, and 15 September 1843.
[66] One of the oldest European-settled areas of Canada, the population of Gaspé was nevertheless fewer than 20,000 in the early 1840s, divided into three main groups: Natives (Mi'kmaq), French-Canadians, and descendants of Loyalists. J. Bélanger et al., *Histoire de la Gaspésie* (Montreal, 1981).

hammer. I am like a stumped Bull in fly time," he wrote. "I can only point to the fossil spot. This will produce sad delay. The weather is so fine and may soon break up. I shall fret myself to death."[67] Without the ability to get his Canadian fossils out of the Earth, and into a museum where they could be properly classified, fieldwork was in vain. Once again, the conditions of doing science in the wild were sufficiently challenging to produce an emotional response in our geologist.

A final telling example of the inextricably physical and sensory relationship between Logan's tools and his scientific work is that of his spectacles. In mid-September Logan reported that:

> While washing my face I put my foot on my gold spectacles, + broke one of the lenses, twisting also the frame. I have two spare pairs of steel framed spectacles, but I cannot take a sight with my compass with these. I must wear them while not using the compass, + employ the remaining lense of the gold ones while surveying. For work I have lost an eye.[68]

Evidently, the more demanding optical needs of surveying by prismatic compass presented yet another vulnerability in Logan's project. Two weeks later, he included a small sketch in his journal of the broken lens, cracked across and with a piece missing, in effect illustrating that his glasses had succumbed to the classic trap of any instrument used to perceive of the world: instead of functioning transparently, as an object to look

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[67] Logan, 1843 Journal, entries for 27-30 September 1843 inclusive. He had found on previous occasions that even skilled workers like blacksmiths were often absent fishing; see entry for 24 July 1843.

[68] Logan, 1843 Journal, 13 September, f. 71v. On the subject of early Victorian eyewear, its uses, expectations, and above all limitations, see A. Briggs, *Victorian things*, rev. ed. (Stroud: Sutton Publishing, 2003), chapter 2, "The Philosophy of the Eye," especially pp. 83-102.

through, his lens had itself become the object to look *at*.[69] Here again, Logan's journal offered him the occasion to reflect on such metascientific issues that underlay his efforts to instaurate geological surveying in Canada. In breaking his spectacles, Logan was forced to acknowledge the fact that his ability to see in the field was always going to be in many senses limited and partial. In response, he used the medium of his journal to bring such problems under analysis, in an effort to remain in control of his experience. Nevertheless, in this respect, the subject of Logan's first field season in Canada was, as much as the territory, Logan – and his physical experiences – himself; this theme will be taken up in greater detail below, in this chapter's final section.

Thus, while British scientific practices of surveying and collecting formed a framework for Logan's field activities, the environment in return provided pressures which made it clear to Logan just what was essential in his endeavours: namely, the disciplined care of observational tools and records. But beyond the physical work he had to do, what of the intellectual task? Was it easy to see and understand the Gaspé coast with the same confidence and authority that he had felt at Joggins in Nova Scotia? Initially, Logan did try to interpret the Canadian strata in familiar terms. In some of his early field notes, he suggested that certain clay beds resembled very much the *Stigmaria* formations that he had detailed so thoroughly under coal seams in South Wales and elsewhere. "If I had seen this bed in a known coalfield I should immediately have called it a stigmaria bed."[70] But although the plant fossils were indeed similar, he decided that "on closer identification" the identification was "by no means certain," and he did not pursue this approach further.

[69] Logan, 1843 Journal, 27 September, f. 84r.
[70] Logan, 1843 Gaspé, FN 1964, entry for 11 July 1843.

Lacking firm geological information about the exact nature and position of his rocks, Logan adopted the additional strategy of compensating by recording as much additional information as possible.[71] The task of locating and identifying formations, and placing them in their correct stratigraphical order, is essentially a relational one. The meaning of any particular unit in the system is largely defined by its relationships to the other units: for example, Logan identified a thick band of limestone conglomerate which he inferred lay *under* the coal-bearing rocks of Nova Scotia and New Brunswick, but *above* all the other rocks of Gaspé. Such observations could be made solely by relative means, and allowed him to be certain that coal did not exist in Canada, even without knowing the exact lithology, fossil contents, and age of the Gaspé formations.[72]

In an effort, then, to make his observations as relevant as possible, Logan took copious notes on each and every phenomenon he encountered, whether natural, cultural, or economic. He wrote about (and sketched) animal traps, thunderstorms, the paradoxes of the fishing economy, the construction of a native "wigwam," and the tragic history of the Isle Percé. In the words of his Victorian biographer, Logan recorded even "the most trivial things and circumstances. John Basque's summer residence, for example, is described with as minute detail as if it were a profoundly interesting geological phenomenon."[73]

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[71] Burnett, *Masters of all they surveyed*, develops a notion of "aesthetic saturation" or overdetermination to describe this phenomenon. See, e.g., p. 147.
[72] W. Logan, RP 1844, "Succession and distribution of rocks of the district."
[73] Harrington, *Life of Logan*, p. 149. Logan's description of Basque's home and family occurs in his Journal, entry for 16 July 1843. Harrington clearly had access to this journal before it was deposited in NLW, for he quotes numerous examples from it and its companion volume in his Chapters IX and X.

While not all of these observations add strictly logical weight to Logan's surveying work, he clearly felt that this 'total' approach contributed a significant air of authenticity to his geological efforts.[74] They proved that he had been in a specific place at a specific time, and that he saw the world with a disciplined scientific eye: these were necessary preconditions to the validity of his geological conclusions. "My field book is a curiosity," he wrote to De la Beche, director of the British Geological Survey. "Every line is a fact."[75] If Logan could not refer to the work of other geologists in order to ground his observations, and could not establish a direct connection between the rocks of Gaspé and those of better-known areas like Nova Scotia – both strategies which would have normally been employed in British practice – he could at least refer to his extensive experience of Gaspé itself, as a natural and a human place, to give authority to his findings. Even if he never intended to publish the notes in his journal, they would serve as a valuable reminder to him of the specific locations and conditions he had experienced in making the scientific observations kept in his field notebook.

In adopting this strategy, Logan had to make carefully calculated use of local knowledge. After all, nearly every fact and phenomenon he noted had been pointed out

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[74] For studies of the rhetorical strategies used in other North American scientific exploration journals around this time, see A. Furtwangler, "Do or die, but then report and ponder: palpable and mental adventures in the Lewis and Clark journals," in Edward C. Carter, II, ed., *Surveying the record: North American scientific exploration to 1930* (Philadelphia: American Philosophical Society, 1999), 267-278; and B. Hume, "The romantic and the technical in early nineteenth-century American exploration," in Carter, *Surveying the record*, 301-316. Both of these observe a typical alternation between the romantic/heroic and analytical/scientific modes of writing. See also I. MacLaren, "The aesthetic mapping of nature in the second Franklin expedition," *Journal of Canadian Studies* 20 (1985): 39-57.
[75] Logan to De la Beche, 20 April 1844, DBP.

and explained to him by the inhabitants of the peninsula.[76] While he relied heavily, just as he had in South Wales, on local residents for leads, he had to preserve a distinction between being shown something and being told what it really signified.[77] His method was to use local knowledge as a source for observations, not as a substitute for them. It was only Logan, the metropolitan scientific gentleman, who could determine what was significant about local phenomena. Why else had he been hired, in the first place?

This double attitude to local views caused a tension in Logan's journal and field notebook. On the one hand, residents of Gaspé were an invaluable source of information about the history and geography of the region.[78] On the other hand, it was important for Logan's own purposes to portray local beliefs as unscientific, unsympathetic, or just plain ignorant. For example, Logan seemed to relish the quizzical treatment he received from many Canadians; he displayed their incomprehension proudly as proof of the value of his work. Early on, he reported that: "Two men came after me a considerable distance today evidently watching my movements very narrowly. They spoke to me at last, and it seems they had considered me from my various gambols about the rocks, out of my mind. Three clam diggers did me the favour to inform me the same thing yesterday. I shall get

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[76] A nice study of the importance of such information in field studies is D. Schneider, "Local knowledge, environmental politics, and the foundation of ecology in the United States: Stephen Forbes and 'The lake as a microcosm' (1887)," *Isis* 91 (2000): 681-705.
[77] See chapter 2 above; it was on leaving his South Wales notebooks for De la Beche that Logan warned: "Your difficulty would be to distinguish between what is correct and what is erroneous. Many things were put down as hearsay to be inquired into. The amount of nonsense I have been told is very considerable." Logan to De la Beche, 4 August 1842, DBP.
[78] Logan, Gaspé FN 1964, entries for 8 July and 21 September 1843, contain typical examples of reference to alleged mineral deposits.

much reputation here evidently."[79] Logically, it was just because so few Canadians appreciated what Logan was doing that he could make a new kind of contribution to the colony.

Properly speaking, of course, one should refer not to Logan's use of "local knowledge," but of local *knowledges*. For Logan made just as much use of the experience and perspectives of the native people of Gaspé, as he did of the fishermen's. One important axis of difference between the two was the dichotomy between coast and woods. Almost all of the European settlement was coastal, and geared to the fishing economy. Natives were vastly more familiar with the inland areas, and the ways of navigating rivers and mountains. Both kinds of knowledge were important to Logan's survey. At the most basic level, Mrs. Basque's roasted young porcupine and fresh seafood supplied by fishermen were both very welcome changes from the navy-style salt pork and ship's biscuit that Logan had naively purchased for the expedition (see below).

Logan was also deeply impressed by John Basque's wood lore (as well as his ability to find lost notebooks): the uses of birch bark, in particular, fascinated him to no end. As with the fishermen's opinions, though, he also made a distinction in this case between the scientific and indigenous uses of such knowledge. Rather than contrasting geological and popular beliefs, he articulated a more fundamental difference between his use of birch bark, and Basque's:

> I do not know what we should do in the woods without Birch bark. It is certainly one of the most useful things an Indian can boast of. He makes

[79] Logan, 1843 Journal, entry for 18 July 1843. Many of the episodes quoted by Harrington are of this nature, and it has remained a powerful historiographical theme ever since. See also R. Bell, *Sir William E. Logan and Geological Survey of Canada* (Ottawa, [1910]), for a further elaboration of this topic.

> his canoe of it. He uses it for roofing his house. He makes of it vessels to carry his maple sugar and his gum, and twisting it as a chemist does his filter he makes a cup of it and it serves him for crockery. Then it is a most inflammable thing and burns like pitch. He lights his fire by means of it, and catches his fish with its assistance. He does not write on it because he can not, but it makes a capital substitute for paper, under either the pencil or the pen, and to save paper I have been using it for my rough calculations. It can be split into sheets as thin as tissue paper.[80]

This excerpt provides a incisive view of how Logan thought of himself in relation to the native people of Gaspé. It was, after all, precisely his written observations and calculations that made the geological survey valuable; here he was, using a resource well-known to the ancient inhabitants of the region, but in a way that he casually assumed was beyond their imagining.

It is perhaps fitting that, as rough notes, Logan's birch bark writings were left behind in the woods. For when he returned to Montreal at the end of the field season, and began the process of transforming his Canadian observations into British science, these were not the only elements of his experience that disappeared. Just as he regularly denigrated local ideas of geology (in light of what a real geologist like himself knew), describing a kind of intellectual wilderness, Logan took pains to emphasize the natural and social wilderness in which he worked. He told De la Beche, his British counterpart, that he had spent the summer working "like a slave ... living the life of a savage." It went without saying that geology in Britain was not practiced by slaves and savages. Logan

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[80] Logan, 1843 Journal, entry for 11 August 1843.

did not neglect to mention his hard nights "[s]leeping on the beach ... eating salt pork and ships biscuit," but he conveniently forgot to include the hospitality and fresh food he frequently received from natives and fishermen alike.[81]

This creative omission should not be taken as an act of ingratitude: Logan was usually generous in acknowledging those who had assisted him. Instead, it should be seen as a rhetorical strategy, to underscore the difficulty of doing geology in Gaspé, and to explain why the results of the first season were so underwhelming. Having done his utmost to interpret unfamiliar Canadian geology in familiar British terms, Logan was not satisfied with the outcome, and was very reluctant to publish his work in its unfinished state. The Canadian government pressed for a formal report, however, and in an effort to satisfy legislators Logan submitted the entire Joggins section from Nova Scotia along with very brief comments on what he had actually done in Gaspé.[82]

This led to the ironic situation in which the single largest component of Logan's first report as Provincial Geologist of Canada was in fact a detailed study of a formation in Nova Scotia, a separate jurisdiction. Of his four months in Gaspé, which had generated hundreds of pages of field notes, and geological observations on thousands of feet of strata, Logan would say only this: "I then entered upon operations in Canada,

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[81] Logan to De la Beche, 20 April 1844, DBP. For example, in the first week of September, Logan stayed with a "Mr. Moriarty" while exploring the area around Percé. See Harrington, 162-167, and Journal and Gaspé field notebook entries for these dates.
[82] Logan, RP 1843. Zeller, *Inventing Canada*, analyzes Logan's report-making strategy in some detail, 56-65; also S. Zeller, "Mapping the Canadian mind: reports of the Geological Survey of Canada, 1842-1863," *Canadian Literature* 131 (1991): 157-167. See also section 3.1 above and chapter 5, below.

devoting myself to a very minute and detailed investigation of the coast between Cape Rosier and Paspebiac, including short distances up some of the main streams."[83]

In this section, I have tried to describe the tasks that Logan faced in conducting a pioneering survey of a land that was, in geological terms, essentially unknown, and how he tried to make the terrain familiar in European terms. I have examined how his geological mapping depended on the maintenance of a disciplined observational regime; how Logan struggled to put Canadian rocks in their proper stratigraphical place; and how this process was in constant tension because of misplacing – the loss of crucial tools, records, and samples, which threatened to undo his careful work and to undermine the scientific status of his Canadian geology.

Finally, I have argued that Logan defined his experience in opposition to the human and natural environments he encountered. Although he depended heavily on the local knowledges of native and European inhabitants in making his survey, he simultaneously distanced himself from their beliefs and practices in order to demonstrate his own scientific attitude. In doing so, and to account for his difficulties in bringing the land under British geological control, Logan went out of his way to highlight the wildness of the Canadian East.

In the final section of this chapter, I want to push the analysis of Logan's field experience one step further – beyond the technical aspects of his work and how he presented it to others, to examine the function of Logan's personal writing for himself. Arguably, Logan's Gaspé journal is above all an account of his own person in the field,

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[83] Logan, RP 1843. This part of the report is dated 27 November 1844; in other words, it was only composed after the second field season was complete. By then, Logan was working on his more detailed second annual report.

not as an observing subject, but as the object of observation itself. Logan's detailed reflections on his physical and sensory life can thus be seen as a logical response to the pressures imposed by the fact that geological surveying placed so much importance on the experience of the individual scientist in the field.

3.3 A Taste for the Work

While Logan paid great attention to his personal physical state, the sense to which he most notably and perhaps unusually paid attention was taste. As his assistant Alexander Murray later recalled, "In spite of his indifference to luxury of any kind, and the extreme simplicity he affected in his mode of living, he was an exquisite judge of wines and the good things of the table."[84] Logan's 1843 Gaspé journal bears out this claim: despite the usual complaints about poor diet that were a standard part of the rhetorical claim of sacrifices made for science, the full range of his field experience shows a much more intricate relationship with environment. The beginnings of Logan's obsession with camp food can be traced almost to the first bite of the first meal that he and his small party prepared on their first night in the woods, the first time they had had to fend for themselves. That night, reflecting ruefully on his inaugural *al fresco* experience, Logan wrote in his diary, "We have had our supper. Tea without milk, navy biscuit & fried ham. But the ham is as salt as Lot's wife. We did not boil it before frying, which must be done next time. To prepare for tomorrow's breakfast I have ordered a piece of pork to

[84] Alexander Murray, "Anecdotes of the life of William E. Logan," [to John W. Dawson], folder 134, box 3, LP/MUA; p. 3. Murray then went on to claim that Logan "could dine upon rusty pork and maggotty biscuit as complacently as on turkey stuffed with truffles, or a pâte de foie gras," a wishful statement not borne out by Logan's experience as recorded at the time, as will be seen in the remainder of this chapter.

be boiled and soaked."[85] Although salt pork – or, more properly, salt-cured pork (a type of fatty, unsmoked bacon) – was a staple of early nineteenth-century North American diets, and widely used at sea and on other long voyages, our intrepid explorers were less than fully aware of what to *do* with it.

This minor trauma was that much harder on Logan, because he really cared about food. It is in fact one of the relatively few things known about his personal tastes, and is perhaps at least partly explained by the fact that his father had been in the baking trade when the family lived in Montreal. And as a young man in England some twenty years before his return to Canada, while his friends wrote sonnets praising women, battles, and other conventional themes, Logan had prepared an ode on his own favourite subject, dinner.

It is the hour, when through the house,
    The dinner bell's high note is heard;
It is the hour, when meet the nose
    Sweet savours; -- dinner is the word,
And knives, & forks, & dishes near,
Make music to the gourmand's ear.
Around the board the guests have met,
With Bacchus' Juice their lips to wet,
And on the right is Irish stew,
And on the left a French ragout,
And at the top, whose Steams allure,

[85] Logan, 1843 Journal, f. 3v.

Is gravy soup, so darkly pure,

It fasts [*sic*] yields to the Ladle's sway,

And melts beneath the Spoon away.[86]

Notably, Logan's description of mealtime appeals not only to the tongue but also to the ear ("high note," "make music"), the eye ("darkly pure") and the sense of touch ("lips to wet"). But how are poetry, geology, and salt pork related? What can food – eating habits, meal planning, and related beliefs and attitudes – tell us about how science worked in the British empire? And why is it important that the surviving journals of a gentleman who explored the eastern Canadian coast in the early 1840s show that he just couldn't get food off his mind?

The answers to these questions bear on three related problems. The first is the question of how the "field sciences," like geology, differed from laboratory sciences: how did the methods used and skills required change when the goal was to obtain specific knowledge of specific places, rather than universal knowledge applicable everywhere? While all sciences require highly disciplined and formalized observation, usually in the lab, a survey (geological or merely topographical) requires extending such observation spatially over longitude and latitude, into every corner of a territory. This made for an interesting dynamic between local and expert knowledge, as Logan had already discovered in his collaborative work with the British Geological Survey in South Wales in the 1830s. On the one hand, a visiting geologist was absolutely dependent on local residents for their knowledge of the surrounding area and its natural phenomena; but on

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[86] NLW, Glandovan collection, Group I, bound volume (July 1822), p. 3 Gravy soup is a chicken broth gratinée, apparently from Basel, Switzerland. Logan would have been twenty-four years old when he wrote this.

the other hand, local beliefs about geology and potential mineral riches had to be deeply discounted if not rejected outright. The need for a surveyor to visit each area personally, and assess not only the local rocks but the local ideas about rocks meant that geologists had to be able to find their feet quickly in an unfamiliar place, establishing a sense of how *this* place was like and unlike others.[87] While most British geologists still worked in well-known areas at home or in Europe, Logan found himself working overseas in the empire, virtually on foreign ground.

A second question concerns the interaction between imperialism and science: how did the practice of Western science in overseas colonies affect the meaning and impact of the imperial relationship, and the kinds of scientific results that were produced? Despite the vast literature on scientific exploration and empire,[88] relatively little has been written so far on the specific science of geology, and on geological surveying and mapping as imperial projects.[89] Obviously, to remedy this is one of my goals. But another, more general goal, is to take a lesson from the practice of nineteenth-century geology and examine phenomena "in situ." If one wants to know *how* a historical process (like imperial science) operated, one has to go to the *place* in which it operated. History, like

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[87] Some years later, Logan would explicitly equate rocks and people in his work, describing before a Parliamentary committee "veins of knowledge" and fossils as "friends." See J. Langton. "Report of the Select Committee," Appendix L, JLA 1854-5; and discussion in chapter 5 below.
[88] A good recent starting point is R. MacLeod, ed., *Nature and empire: science and the colonial enterprise. Osiris*, 2nd series, vol. 15 (2000). For a survey of British Victorian imperial science, see R. Stafford, "Scientific exploration and empire," in A. Porter, ed., *The Oxford history of the British empire, vol. III: the nineteenth century* (Oxford, 1999), 294-319.
[89] Exceptions are R. Stafford, "Annexing the landscapes of the past: British imperial geology in the nineteenth century," in J. MacKenzie, *Imperialism and the natural world* (Manchester, 1990), 67-89; and S. Zeller, "The colonial world as a geological metaphor: strata(gems) of empire in Victorian Canada," in MacLeod, *Nature and empire*, 85-107.

geology, requires fieldwork; it can't be done from the armchair. In archival terms, this means we have to look at the transitory, day-to-day records of imperial science as it happened; we can't look only at the final results (geological maps, official reports, museum exhibits, and so on). If we know what colonial surveyors ate, I argue, we can learn something about how they thought, and how they experienced and interpreted their environments.[90]

This brings us to a third and final issue, the biographical one: how do the issues just mentioned play out in the person of the individual scientist? What is the relationship between ideas and the physical person who has them? In recent years, there has been a revival of interest in scientific biography, coinciding with a historiographical understanding of science as a highly social process in which personal credibility, built upon appeals to existing structures of cultural authority, plays a key role in the legitimation of new knowledge.[91] Thus, we no longer believe that scientists are really isolated geniuses who simply ponder great questions in the privacy of their own minds; instead, they are skillful impresarios whose public selves function rhetorically to define not only what true knowledge is, but, more importantly, to argue that it is only they who can make it. Steven Shapin, one of the sociologists most responsible for this view of science, took this emphasis on the personal one step further in directing attention to the role played by scientists' physical bodies, and even more specifically to the issues of food

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[90] On the uses of sense experience in historical writing, see P. Hoffer, *Sensory worlds in early America* (Baltimore: Johns Hopkins University Press, 2003). Hoffer refers to the role of sensation in coming to grips with new worlds (chapter 1). For the idea that "perceptual relations are also social relations," and a critique of over-reliance on purely visual evidence, see D. Howes, *Sensual relations: engaging the senses in culture and social theory* (Ann Arbor, MI: University of Michigan Press, 2003), pp. 40, 54.
[91] M. Shortland and R. Yeo, eds., *Telling lives in science* (Cambridge, 1996).

and diet as they relate to the scientific life.[92] Shapin has traced a long history of idealized asceticism, in which philosophers, hermits, and (eventually) scientists appealed to an enduring strategy of denying the body to privilege the mind. Anything but the plainest foods, in the smallest quantities, represented a temporal distraction from higher matters, and was likely to be a corrupting influence that undermined the project of achieving transcendental knowledge, whether of beauty, God, or the laws of physics. According to Shapin, there is a strong cultural tradition which asserts that "the truth-seeker is someone who attains truth by denying the demands of the stomach."[93] This does not mean that all scientists were really or always ascetics, of course – only that it was to their rhetorical advantage to appear so. Shapin's examples, like Isaac Newton, come from the field of natural philosophy (i.e., physics). In this kind of knowledge, truth is that which is independent of place, time, and merely transitory phenomena like what the observer had for lunch. But geological knowledge, of stratigraphy and other phenomena whose existence was in their very geographic extension, was quite different – it did depend on local circumstances, and on the observer's ability to cope with such vagaries. With this in mind, we can now return to William Logan and his unsatisfactory first camp dinner. As we will see, his relationship with food continued to be fraught throughout his first season in the field.

Setting out on his expedition earlier that same day, Logan had surveyed the contents of his canoe with evident satisfaction: "What with our rifle, barometer, carpet bag, valise portfolio, half a hundredweight of ships biscuit, 40 lbs of pork, our tent, and

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[92] S. Shapin, "The philosopher and the chicken: on the dietetics of disembodied knowledge," in C. Lawrence & S. Shapin, eds., *Science incarnate* (Chicago: University of Chicago Press, 1998), 21-50.
[93] Shapin, "The philosopher and the chicken," p. 22.

our good selves we have a pretty decent load."[94] Logan's choice of supplies is revealing of the kind of experience he expected to have. Gaspé presented to Logan an unknown place, about which he could have no certain expectations. Its unfamiliar geography and unsettled interior disrupted his ability to plan ahead. Shortly before setting out, he wrote to his mentor in Britain, "My address in the Gaspé district will be uncertain."[95] In an effort to combat the foreign with the familiar, he provisioned his party with large quantities of durable foodstuffs, as if they were headed out to sea, or into some uninhabited desert.

The irony, and fatal weakness, of this idealistic strategy was brought home to Logan almost at once, in that first excruciatingly salty bite of ham. To a lover of food, there was nothing comfortingly familiar about over-preserved meat. The next day, Logan made a point of shooting several partridges and instructing his Mi'kmaq guide, John Basque, to prepare one of the birds: "We had one of the partridges for supper and most excellent it was. We had it fried with a little pork and Basque has added some wild sives [i.e., chives] to the mess which gave it a most admirable flavor. Sives beat onions out and out."[96] But if local food was clearly superior, in Logan's eyes (or mouth), it was not a thing apart. After all, Basque's recipe also incorporated some of the salt pork they had brought with them, and the resulting flavours, though exquisite, were not alien: Logan

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[94] Logan, 1843 Journal, f. 1, entry for 13 July.
[95] Logan to De la Beche, 31 May 1843, DBP.
[96] Logan, 1843 Journal, f. 7, entry for 14 July. It seems likely that Basque had also cooked the night before; quite possibly he was not in the habit of eating salt pork himself and was unfamiliar with its correct mode of preparation. On how to read white accounts of aboriginal culture in early nineteenth-century Canada, see E. Vibert, "Real men hunt buffalo: masculinity, race and class in British fur traders' narratives," *Gender and History* 8 (1996): 4-21.

could readily compare wild chives to the familiar taste of the onions he might otherwise have expected.

A few days later, on Sunday, the party stayed at John Basque's "wigwam," bringing with them several porcupines that they had killed in the woods, and some fish that they had liberated from nets across a river.[97] Turned into food, these wild animals were readily assimilated into Logan's experience: "Basque's wife cooked for us some of the trout we stole last night for breakfast, and for dinner she gave us roasted porcupine. She chose the young porcupine, and certainly it made an excellent dish. It tasted rather better than sucking pig but the flavor of the meat was something like it."[98] Here is another clear example of how it was possible to understand the unfamiliar local environment in familiar terms: having only recently encountered porcupines, Logan had been entranced and bemused by their odd appearance and behaviour in life; but killed and eaten, they posed much less interpretive challenge.

In addition to aboriginal cuisine, the fact that the majority of local inhabitants, living in small communities up and down the coast, were engaged in various forms of fishing, made it easy for Logan and company to acquire a steady supply of fresh food. Complaining of eating "toujours salt pork," he wrote "I have been begging of the fishermen, about me, who have regularly supplied me with fresh herring, codfish, and mackerel."[99] Vegetable products provided another way of getting to know the environment: "We had purchased half a bushel of potatoes in the morning from a trading

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[97] Logan also discussed the legal issues concerning this method of fishing in his journal.
[98] Logan, 1843 Journal, f. 10, entry for 16 July. Logan's compulsion to submit everything he saw to his surveying project caused his Victorian biographer to remark that the scene at the Basques' was "described with as minute detail as if it were a profoundly interesting geological phenomenon" (Harrington, *Life of Logan*, p. 149).
[99] Logan, 1843 Journal, f. 13, entry for 21 July. Lobster was also readily available.

schooner now in the bay... and so we had a grand supper with a first and second course, for there remained some of the pea soup of yesterday.... The potatoes are good. They are from Prince Edward Island, the garden of this part of the world."[100] Potatoes were anything but unfamiliar, and it was good to know that they grew well here too, and that "this part" of the world had its own garden.

Finally, members of the surveying party could also create their own recipes, forging new kinds of food by adapting their existing rations to fresh purposes. John Stevens, the third member of Logan's team, found that chewing rock-hard ship's biscuit was simply beyond his dental capacity. Logan enthusiastically recorded the young man's response to this painful conundrum: "Stevens has brought to my mind an excellent mode in which to prepare our hard biscuit. The condition of his back teeth has made him think of it. The way is to soak them well in water. Then to toast them and spread butter on them. They become as soft and much better than loaf bread. Instead of toasting and buttering Stevens prefers frying his in the fat resulting from our fried ham."[101]

At the end of their first two weeks in the field, then, Logan and his assistants had gone from struggling with salt pork and ship's biscuit, to creating hybrid dishes that employed a variety of ingredients, techniques, and cultural styles.[102] The foods Logan had originally purchased seemed at first virtually inedible, rather than being a stable and reassuring presence.[103] Indeed, desired as ideally stable foodstuffs, salt pork and ship's

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[100] Logan, 1843 Journal, f. 17, entry for 24 July.
[101] Logan, 1843 Journal, f. 20, entry for 27 July.
[102] For a discussion of the wilderness food of early geological explorers in the Keweenaw region of Lake Superior in the same time period, see L. Lankton, *Beyond the boundaries: life and landscape at the Lake Superior copper mines 1840-1875* (New York: Oxford University Press, 1997), pp. 68-70.
[103] Tea was their other staple, and its role would be worth investigation in its own right.

biscuit turned out to be anything but; they functioned more as challenges to be overcome than as reliable resources. Yet when used as raw materials, these ingredients proved more versatile (as John Stevens discovered), and the surveyors' ability to make the most of this speaks to different kind of comfort and confidence, more grounded in the exigencies of local conditions. Moreover, Logan's gustatory satisfaction with the fish, flesh, and fowl of the Canadian wilderness indicates that he had found a way to interpret the physical sensations of being in this new place, a way that was at least commensurable with his previous experience.

Now I hope we are in a position to start answering some of the questions raised earlier. How did Logan's sensory relationship to his environment affect his mental perceptions of it? One thing that should be noted right away is that local inhabitants identified Logan with his scientific activities just as readily as he thought of them in terms of the fishing industry, and as a source of food. Their exchanges rapidly became ritualized: "As usual when the fishermen returned from their day's work, they all flocked round my tent to the number of about a dozen, to wonder at our instruments and whole equipage. I beg my fresh fish of them as usual in return."[104] Further, discussions of the food-quality of fish provided a common ground between Logan and the locals, a crucial step in evaluating whether or not they might see eye to eye on other matters. So when Logan wrote: "The flat fish is here despised and rejected of the fishermen. One of the them would consider himself insulted by the offer of it. But I found it excellent and liked it better than the cod," he reinforced a cognitive distinction between his kind of

[104] Logan, 1843 Journal, f. 21, entry for 28 July. On the lives of the fishers and details of the fishing and fish processing industries, see R. Samson, *Fishermen and merchants in 19th century Gaspé* ([Ottawa:] Parks Canada, 1984). Logan's journal is a valuable historical resource for such topics in their own right.

knowledge and theirs.[105] Inhabitants of this place called Gaspé might be able to show him natural phenomenon of interest, but they could not teach him what was important and what was not. A rock they thought was coal he knew was worthless. A fossil they thought meaningless, he knew to be essential.[106]

Even more important, though, is the interaction between sensory data and knowledge of place. Notably, Alexander Murray, the GSC's longstanding assistant geologist under Logan, once said of him, "Even his ordinary senses were singularly acute; he was delicately sensitive in taste, touch, smell or hearing; and although very short-sighted his vision was of marvellous power."[107] Indeed, there is a growing attention in historical writing to all the senses, not only sight and sound, but also to the "proximity senses" of touch, smell, and taste. Joy Parr, a leader in this field, has written for example on the relationship between technology and environment from the point of view of the senses: she argues that bodies "learn, know, and remember far more than can be expressed in words," and that we have to try to recover this component of experience in order to gain perspective on histories dominated by linguistic, discursive, textual sources.[108] And, from another perspective, Graham Burnett has emphasized the

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[105] Logan, 1843 Journal, f. 17; he believed the flat fish was plaice (presumably less suitable for export and thus less valued, as was lobster). Like rocks and minerals, cod was an important natural resource, yet one for which sense perception and economic value could be at odds; Logan might have begun already to think about how he would convince Canadians to become enthusiastic about their mineral resources, at the same time as he was realizing the importance of diversifying from a one-product economy.
[106] Logan's attitude to local knowledge in general is treated in more detail above. His experience in both South Wales and Canada involved a great deal of sorting out good leads from "nonsense."
[107] Alexander Murray, "Anecdotes of the life of William E. Logan," [to John W. Dawson], folder 134, box 3, LP/MUA; p. 3.
[108] J. Parr, "CHR Forum [Notes for a more sensuous history of Canada]," *Canadian Historical Review* 82 (2001): 719-45; J. Parr, "Lostscapes: found sources in search of a

importance of attending to the physical, sensory life of imperial explorers, as a way of discovering alternatives to hegemonic narratives of territorial acquisition, written from above and after the fact. Instead, in his study of Richard Schomburgk's travels in Guiana (contemporary with Logan), Burnett emphasizes the surveyor's "active engagement with the land" arguing that "places were unique, particular, and diverse [and] that they had to be plotted with respect to lines of emotion, experience, and movement."[109] Logan's ceaseless attention to what he ate, how it was prepared, and what he thought of it, show his concern for letting no aspect of his experience in the field go unscrutinized.

Ultimately, for Logan, the challenge in Gaspé was to find a way to continue as the successful geologist he had been in Wales, and even at Joggins. But Gaspé was not Wales, and instincts that had served him well before might serve no longer. He was looking for coal, his knowledge of which underlay his British geological reputation; he attempted to identify characteristics patterns of coal formations in his first few days in Gaspé, but quickly gave up when it became obvious to him, as he had rather suspected all along, that there would be no coal in Canada.[110] But, as we have seen, he was able to make sensory connections between Gaspé and Wales in other ways, connections that proved that what he had perceived once, he could perceive again in this new land. An

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fitting representation," *Journal of the Association for History and Computing* 7.1 (April 2004); J. Parr, "Smell like?: sources of uncertainty in the history of the Great Lakes environment," *Environmental History* 11 (2006): 269-299. See also C. Classen et al., *Aroma: the cultural history of smell* (New York: Routledge, 1994).

[109] Burnett, *Masters of all they surveyed*, pp. 11-12. Burnett is inspired here by the writings of Paul Carter on Australia.

[110] As Logan had indicated to De la Beche before setting out, if the strata were unfavourable, "I shall fear that the coal is not the productive portion of the deposit. I have my apprehensions about it already." 31 May 1843, DBP. See also his oblique comments even in his "Preliminary Report" to the Canadian government, which to a knowledgeable reader would have indicated the (im)probability of the U.S. coal fields extending into Canada; RP 1843.

example from another sense, hearing, puts this perfectly. When Logan spent Sunday at John Basque's house, he had the following experience: "Basque's wife seems to have an Indian missal from which she and all in the house sang some sacred music. It had much the character of the Welsh psalm tunes, and the one language being to me nearly as unintelligible as the other, I could almost when my eyes were shut fancy myself in Mr Jones' church at Kilgerran."[111] By temporarily and forcibly denying himself the use of his dominant sense, sight, Logan could imaginatively collapse the mental and physical distance between Wales and Gaspé.

Coming to my final question, I believe that it is exactly in the biographical, in writing Logan "from the inside," that my questions about eating and the environment, science and place, imperialism and the individual, come together most productively. The experiences of one British gentleman, in a small, outlying part of one colony, over the course of as little as a few weeks, are a fruitful and important site for the examination and understanding of how science and empire worked together *in situ*. Food offers us a way at least partly to recover what it was like to be Logan in the field. Steven Shapin has argued that "[empirical inquiries into the local production of meaning] can never be *too* local."[112] I would extend this maxim to studies of empire as well. Logan's insight that knowledge begins with local, small-scale observation is one that we can take up

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[111] Logan, 1843 Journal, f. 10. Logan's family was Scots; he had been in Wales only to manage a business interest. Nevertheless, one of his key accomplishments there was negotiating the invaluable local knowledge held by experienced coal miners. So the remark about language is not incidental; it represents a potential stumbling block that he had successfully overcome before. At the same time, it points to a similarity in status and relationship to Logan, between the Welsh miners and his Native guides in Gaspé.

[112] S. Shapin, "Placing the view from nowhere: historical and sociological problems in the location of science," *Transactions: Institute of British Geographers* 23 (1998): 5-12, quoting p. 9.

ourselves. Just as geologists are a kind of historian, the scientific explorer's "art of being there" – of rooting out and recording the most intimate, local, and transitory details – has much to offer the practice of history.

It is thus clear that science, environment, and diet were closely linked in Logan's daily personal life. Finally, we can look more closely at how food helped make the survey an imperial endeavour. First, it is worth noting that Logan initially denied that he had "gone native," so to speak, retreating to an idealized position like the one outlined by Shapin in which the scientist claims to be unswayed by food. "I worked like a slave all summer on the gulf of St. Lawrence," he wrote back to Britain, "living the life of a savage, inhabiting an open tent, sleeping on the beach in a blanket sack, with my feet to the fire, seldom taking my clothes off, eating salt pork and ships biscuit."[113] Despite the pleasure with which Logan had written about local foods in his personal diary, he chose to portray himself as a uncorrupted British scientist who had remained above the complexities of the place he'd been, as if the unreflective ideal he took into the field with him had remained unchanged.

Yet after his second season in the field, also in Gaspé, that same sentiment underwent a signal transformation. Then he would write of his gruelling summer: "for three months and a half I had no other bed than the moss which covered the ground, where my food in the way of flesh has been partridges, bears, porcupines, and otters."[114] He would specifically drew attention to the extent to which his life was implicated in the

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[113] Logan to De la Beche, 20 April 1844, DBP. Though not formally a public communication, it certainly suggests how Logan wished to present himself to his professional geological peers in Britain. There is a fascinating tension between the "life of a savage" on the one hand and the eating of salt pork and ship's biscuit on the other.
[114] Logan to De la Beche, 11 November 1844, DBP; barely six months after the previous letter.

surrounding environment, and record that, "We have no biscuits with us, and therefore we bake our flour every morning and evening after the Indian fashion,"[115] acknowledging that ship's biscuit no longer had either practical or rhetorical value to him, even on a journey into the uninhabited peninsular interior. The reasons for Logan's change in narrative strategy, of course, have a lot to do with the failings of the 1843 expedition and the successes of the rather different 1844 trip, as will be seen in the following chapter. But what it shows is that Shapin's identification of scientist with ascetic scholar will not always hold up when geography is at stake. Instead, Logan was also able to mobilize another identity, that of the heroic imperial explorer who goes, sees, and conquers – and, in this case, eats.[116] After his second year on the survey, Logan realized that he could appeal for scientific credibility in a different way: not by claiming to be apart from the environment, but by showing that he was fully at home in it.

It was exactly because Logan's meals supported his surveying in the wild, both literally and figuratively, that food was inextricably caught up in one kind of imperialism. I am not referring here to classic, high imperial behaviour, in which our hero strides across the landscape, ascending effortlessly to the top of the highest hill, and plants the Union Jack on it for all to see, and for him to see all – though in fact, Logan did do just that (as the next chapter shows). Instead, I think of imperialism here as a micro-process, where the issue is not so much "who takes what from whom," but how the land is brought

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[115] Harrington, *Life of Logan*, p. 194. Refers to 11 July 1844.
[116] There is of course a long tradition of associating explorers with what they ate, by choice or otherwise; the best-known examples come from notoriously doomed Arctic and Antarctic expeditions. What objects they had to resort to eating was an index of just how badly things were going, with the most exclusive class of explorer reserved for those who in the end had nothing to consume but each other. (John Franklin's infamous second expedition lasted from 1845 to 1847, making it contemporary with Logan's work.)

under cognitive and discursive control, affecting how it will be perceived and treated ever after.[117] Before Logan arrived in Gaspé, no one knew if coal existed there or not; more importantly, it was not even a place about which that kind of scientific knowledge was possible. But after Logan paced out the coastline, peered at outcrops through his micrometer telescope, measured the bearing and inclination of strata with prismatic compass and protractor, there were results that could be printed in official government reports, exhibited to international audiences in London and Paris, and printed on colour geological maps showing exactly which formations existed at which places. Logan thus served notice that science had done its job, that Canada could and would now be seen just as Britain, Europe, and the United States were.[118]

Personal geological fieldwork was the micropractice of this type of imperial science (if we want to call it that); food in the field provided Logan with a primary way to conceptualize the local environment and to compare it with his previous experience. His imperial relation was thus very much a sensual, visceral one. It is not so far from the hybrid meals that he assembled out of native game, local fish, and expedition rations back to the Irish "stews" and French "ragouts" so beloved of his youth, even if the imaginative link thus formed was as fleeting as the steam floating above the quickly-devoured "gravy soup" that he adored best of all (as in Logan's poem quoted above.) And Logan himself

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[117] For another nineteenth-century Canadian case, with a similar but somewhat different perspective, see G. Gillespie, "'I was well pleased with our sport among the buffalo': big-game hunters, travel writing, and cultural imperialism in the British North American west," *Canadian Historical Review* 83 (2002): 555-584.

[118] See also chapter 6 below. For the context of colonial state-building, of which the Geological Survey was certainly a part, having been paid for by the post-Rebellion legislative assembly, see A. Greer and I. Radforth, eds., *Colonial leviathan* (Toronto, 1992). On the meaning of surveying, see, e.g., S. Daniels, "Mapping national identities: the culture of cartography, with particular reference to the Ordnance Survey," in G. Cubitt, *Imagining nations* (Manchester, 1998), 112-31.

was a hybrid entity, born in Canada, educated in Scotland, self-taught in geology in Wales. Having discovered the virtues of intimate knowledge of local places once already, in the South Welsh coal districts, he was poised to do the same in Canada. All he needed was a starting point, a way in, and in Logan's case that would always be food.

CHAPTER 4

'Wedded to the Rocks'

While the previous chapter examined the personal aspects of Logan's style of Canadian fieldwork, the present chapter seeks to assess the social dimensions of field geology: the relationships among members of the surveying party, and their implications for the social, cultural, and gender identity of the exploration geologist. In doing so, it also touches on Logan's personal life and biography, particularly in the conclusion. The identity of the heroic male explorer has of course been analyzed many times; what is important here is the link between (a species of) masculinity and science. A pertinent example is that of Logan's Scottish contemporaries such as the geographer James Forbes and the geologist Hugh Miller, who have been cited as part of a movement that not only happened to exclude women but also actively inculcated "appropriately male behavior among scientists."[1] Furthermore, as is well known, the link between mountaineering and manliness was ever strong, and Logan's own mountain-climbing adventure will be related below. Finally, however, and also significantly, is the idea that gender identity was also closely related to the practice of self-attention, and to a regime of regular physical self-analysis, based on close monitoring of sensory perception.[2] This allows us

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[1] A good starting point is M. Terrall, "Heroic narratives of quest and discovery," *Configurations* 6 (1998): 223-242. On Forbes and Miller, see B. Hevly, "The heroic science of glacier motion," *Osiris* ser. 2, 11 (1996): 66-86, quoting p. 86.
[2] J. Golinski, "The care of the self and masculine birth of science," *History of Science* 40 (2002): 125-145.

to form a link between Logan's experiences of 1843, as seen in the previous chapter, and those of 1844, detailed herein.

Before starting out, though, it might be asked what really motivates or justifies this attention to the details of daily life in the field: did it truly affect the "scientific content" of Logan's work? Is the geology of Canada actually different because of what he ate or what he wore? In response, I would reaffirm that a geological survey of Canada could not have been undertaken without developing and implementing a normative idea of how it was to be done. Just as British stratigraphers were obliged to base their conclusions on extensive personal fieldwork following the controversies of the 1830s, and just as Logan had to find a way to adapt their methodology to the unmapped Canadian wilderness, this ethos had to be promulgated and put into practice by his lieutenants and successors across the country. Logan's way of doing geology set the standard for the Geological Survey of Canada for at least a generation, and established a moral landmark still endorsed to this day.

As laudable as Logan's accomplishments are, we nevertheless have to seek out all of their ramifications, both positive and negative. His deeply personal field methods made the rapid growth of Canadian geological knowledge possible, but they may have also made other things impossible. At the top of this list is the possibility of female participation in Canadian geology. An investigation of this question ultimately leads back to 1844, and Logan's second field season in Gaspé. But it begins most inescapably in 1926, with the story of Alice Wilson.

4.1 Of Gender and Geology

In April 1926 W. H. Collins, director of the Geological Survey of Canada, rejected an application by Alice Wilson, one of Canada's leading museum geologists, for an academic leave of absence to allow her to earn a Ph.D. and thus qualify for a promotion to field geologist: "Physically and sexually Miss Wilson is not fitted for any but the lightest sort of field work, and only in settled districts. An undesirable condition would be created by attempting to fit her for field duties."[3] Collins's casually dismissive gender views may not seem surprising, given what we know about the historical place of women in science. Indeed, Naomi Oreskes has identified the early twentieth-century field sciences as a particularly clear example of the way in which the essential analytical work performed by female scientists, indoors, was largely invisible in comparison to the highly-publicized field expeditions undertaken by "heroic" males.[4] Although objectivity was of course the goal of science, what set the field scientist apart from other people were the personal sacrifices he made and the bodily dangers he faced as he journeyed to remote locales in pursuit of knowledge that could not otherwise be obtained. Because this heroic identity was not readily available to women (at least, not so long as they also wished to be seen as women), and because women were often excluded from the sites of field science, whether inside submarines or at remote camps, it was all too easy for bureaucrats, the public, and indeed scientists themselves to confuse the work done by male scientists with the scientific enterprise as a whole. Oreskes makes this argument

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[3] William Henry Collins, 28 April 1926, quoted in B. Meadowcroft, "Alice Wilson, 1881-1964: explorer of the Earth beneath her feet," in M. Ainley, ed., *Despite the odds: essays on Canadian women and science* (Montreal: Véhicule, 1990): 204-219, p. 213.

[4] N. Oreskes, "Objectivity or heroism? On the invisibility of women in science," *Osiris* 2nd series, 11 (1996): 87-113.

through her analysis of the case of the U.S. naval astronomer and mathematician Eleanor A. Lamson, and a review of Alice Wilson's story shows that it follows a similar pattern.

Alice Wilson (1881-1964) was among the Survey's first female scientific employees in 1909, and was the first to reach a professional rank, assistant invertebrate paleontologist, in 1919. This job title meant that her duties were primarily restricted to museum work: arranging, describing, and cataloging fossil collections. Nevertheless, she soon emerged as a leader in this area, and as an author of significant paleontological works. In order to be promoted further, however, into the ranks of the real geologists who conducted long field trips into remote areas, she would have to obtain a Ph.D. Although male staff were regularly given leaves for such purposes, and Wilson had taken leaves in the past relating to her museum work, which was highly regarded, from 1915 to 1926 she received a steady stream of rejections in her quest to study for Ph.D. and thus get on the track to field work. Only after she won a scholarship from the Canadian Federation of University Women, and the president of the University of Toronto pressured the highest levels of the federal government, were the strenuous objections of Survey director Collins overcome. Even after receiving her Ph.D., though, Wilson faced deep-seated opposition to any change in her status. Ultimately, it was not until 1936, after the Canadian government had named her to the Order of the British Empire and Collins had lost control of the Survey, that Wilson was reclassified as an assistant geologist, opening the way to upper ranks that she would reach briefly before her mandatory retirement in 1947.[5]

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[5] Meadowcroft, "Alice Wilson"; see M. Zaslow, *Reading the rocks* (Ottawa: Macmillan, 1975), pp. 337-40 for Collins as director of the Survey. For an assessment of her

Although Alice Wilson eventually obtained the public recognition that Eleanor Lamson did not, their experiences are similar in that they experienced firsthand the rigid distinction between office and museum-based data analysis (in Lamson's case, work on computational methods and data reduction) and the field work that was seen to be the real essence of science, excluded from the latter because they could not be masculine heroes. While Oreskes uses Lamson's story to interpret the "invisibility of women in science" generally, arguing that the heroic ideal has been more or less pervasive across time and disciplines, my purpose here is to situate Alice Wilson's struggle in the specific history of the Geological Survey of Canada itself, in an effort to locate the origins of its own masculine field culture. Of course, the general idea of the intrepid explorer as a brave and noble hero has existed for a very long time, but I aim to show precisely how differing masculinities played an overt and explicit role in the nineteenth-century origins of Canadian field geology. In fact, this gendered foundation of the geologist's identity was propagated into the twentieth century, through Alice Wilson's time, and indeed persists right up to the present day.

So why was it, in 1926 (and for the better part of two decades), that Collins was so determined that a woman be kept out of the field? Conditions for Canadian women in any branch of science were of course not good in the first half of the twentieth century, but from the stories of less-impeded women in other disciplines, from botany to nuclear physics, it seems that geologists like Alice Wilson had a particularly hard time.[6] Indeed, Collins argued (as quoted above) that women were by their very nature "sexually"

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geological achievements, see W. Sarjeant, "Alice Wilson, first woman geologist with the Geological Survey of Canada," *Earth Sciences History* 12 (1993): 122-28.

[6] Ainley, *Despite the odds*, includes case studies from a range of sciences, including both field and laboratory work, focusing on the late nineteenth and early twentieth centuries.

incapable of working in the field, necessarily living for extended periods of time away from civilization. He referred vaguely to the "undesirable condition" that would result from any attempt to overcome this natural order. Rather than simply dismissing Collins's attitudes as irredeemable chauvinism, it is far more productive to ask what it was about the men of the Geological Survey of Canada that made *them* "sexually" fitted to work in the field? Why was one's gender seen as such an essential part of conducting science in the wilderness?[7] In Britain, after all, where much field work could be accomplished without leaving settled areas, women made numerous contributions to geology throughout the nineteenth century, following men in the transition from "amateur" to university-trained practitioners.[8] By the turn of the twentieth century, the Scottish

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[7] Despite the substantial literature on women, gender, and science, a surprisingly small proportion of it examines geology; note that Oreskes's paper comes from a thematic *Osiris* volume on field science, not gender. For one treatment, see J. Phillips and K. Hausbeck, "Just beneath the surface: rereading geology, rescripting the knowledge-power nexus," *Women's Studies Quarterly* 28 (2000): 181-202; for a review of some related secondary sources in the history of geography, see C. McEwan, "Gender, science and physical geography in nineteenth-century Britain," *Area* 30 (1998): 213-223. See also G. Rose, "Geography as a science of observation: the landscape, the gaze and masculinity," in F. Driver & G. Rose, eds., *Nature and science: essays in the history of geographical knowledge* (Cheltenham: Historical Geography Research Group, 1992), 8-18.

[8] Mary Anning is the best-known early example, although she did not produce scientific publications; H. Torrens, "Mary Anning (1799-1847) of Lyme: 'The greatest fossilist the world ever knew'," *British Journal for the History of Science* 28 (1995): 257-284. See also M. Creese and T. Creese, "British women who contributed to research in the geological sciences in the nineteenth century," *British Journal for the History of Science* 27 (1994): 23-54; this study acknowledges the unusual prominence of British women geologists relative to their North American peers, and attributes it to cultural factors such as educational opportunities and local scientific societies. However, this fails to explain why a similar pattern does not exist for other sciences, like chemistry and botany, in which North Americans took a much more active role, leaving open the possibility that the physical and practical obstacles to field work were a relevant difference between the two places. See also the articles by M. Kölbl-Ebert in *Earth Sciences History* 16 (1997): "Mary Buckland (née Morland) 1797-1857," 33-38; and "Charlotte Murchison (née Hugonin) 1788-1869," 39-43; and "British geology in the early nineteenth century: a conglomerate with a female matrix," *Earth Sciences History* 21 (2002): 3-25.

geologist Maria Ogilvie Gordon had earned doctoral degrees from London and Munich and performed rugged fieldwork in the Swiss Alps.[9] Why, then, in order to be a real *Canadian* geologist (that is, to work in the remote field), did one have to be above all a man?[10]

4.2 The Road to Mt. Logan

To answer this question, we must shift the focus from twentieth-century women to nineteenth-century men, to the origins of the Geological Survey itself, and to the pioneering field expeditions led by its founding director, William Edmond Logan. In 1843, Logan (with two assistants) had undertaken his first Canadian field season, working along the sparsely-populated coast of Québec's Gaspé peninsula (see chapter 3). Now, in 1844, he returned to the district with a much larger field party, determined to be the first European to cross the uninhabited interior, ascending and traversing the peaks of the "Shick Shock" (Chic-Choc) mountain range. Logan recorded the events of this summer in considerable detail in his journal, which forms the basis of the narrative presented below.[11] In my analysis of what happened on that expedition, I argue that masculinity has been central to doing geology in Canada even from the earliest times. In fact, it was not simply necessary to be of the male sex, as later generations might surmise. Rather, as we shall see, it took a certain kind of man, performing a particular masculine

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[9] M. Creese, "Maria Ogilvie Gordon (1864-1939)," *Earth Sciences History* 15 (1996): 68-75.

[10] The Canadian case has been assessed by Marianne Ainley, in "Women's work in geology: a historical perspective on gender division in Canadian science," *Geoscience Canada* 21 (1994): 139-41, and in "Last in the field? Canadian women natural scientists, 1815-1965," in Ainley, *Despite the odds*, 25-62.

[11] William E. Logan, Journal, Gaspé 1844, MS 21716B, NLW.

identity, to succeed in the woods. Other men, no less masculine, but in different ways, might rapidly crumble, and threaten to bring down the entire enterprise with them. If gender identity was a resource that could help one climb a mountain, it could also pose a danger that had to be carefully checked at all times.

As men, the members of Logan's 1844 field party encompassed a wide range of social, ethnic, and racial identities. Logan, who was forty-six that summer, had as his assistant geologist Alexander Murray, a fellow Scot in his thirty-fourth year. Logan had been born in Montreal and raised in Edinburgh, before working in London and at a copper works in South Wales, while Murray was a former officer in the Royal Navy who had settled at Woodstock in Upper Canada, where he had helped suppress the uprising of 1837.[12] Both were loyal, conservative servants of the British Empire, whose peripatetic career paths, typical of many Scots, had brought them back to this settler colony. The third scientific member of the team was a completely different fellow: the Count Édouard-Sylvestre De Rottermund, a French-speaking gentleman from the Polish provinces of the Russian empire.[13] Exiled at eighteen for his role in the 1830 uprising against Tsar Nicholas I, De Rottermund received some scientific education in Paris and eventually emigrated in 1843 to Canada, where he was now attempting to make a career for himself as a chemist, accompanying Logan's expedition to analyze the rocks and minerals they encountered.[14] Meanwhile, the support crew for the field party numbered

[12] Harrington, *Life of Logan*, 141. After Confederation, Murray went on to become Director of the Geological Survey of Newfoundland, for which he is most often remembered today; DCB.
[13] DCB. Logan often spelled his name "Rottermond," which has been retained in quotations below.
[14] Logan, 1844 Journal, 23 July describes De Rottermund's views on politics and Polish nationalism.

six more men: John Stevens, a young explorer who was the son of a New Brunswick mine owner; John Basque, Logan's Mi'kmaq "Indian" guide, who, like Stevens, had accompanied Logan on the 1843 expedition; Baptiste Basque, Louis Kennetoon, Francis Joseph, and Peter Jean, all also Mi'kmaq "Indians," and Michael (or Michel), a French-Canadian woodsman.[15] Louis was particularly important, as one "who has already been at the summit of the St Anns Mountains, & who was with the American surveyors to examine the boundary of the disputed territory behind Metis [River] so that he will know something of the country."[16] It was this mix of men, containing within them divisions of race, language, ethnicity, class, and politics, who set out from the town of Gaspé at the beginning of June, 1844, bound for unfamiliar terrain.[17]

From the first moment they had set foot on the peninsula, even before they assembled the field party, it was evident to Logan that he and De Rottermund were different sorts of men. When Logan, Murray, and De Rottermund landed at St George's

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[15] The term "Indian" is reproduced throughout this chapter (and elsewhere) because it was the label Logan himself employed. For important reflections on the creation by white explorers of the "discursive Indian," see E. Vibert, "Real men hunt buffalo: masculinity, race and class in British fur traders' narratives," *Gender and History* 8 (1996): 4-21. For an excellent study of native peoples and exploration parties, see D. G. Burnett, "'It is impossible to make a step without the Indians': nineteenth-century geographical exploration and the Amerindians of British Guiana," *Ethnohistory* 49 (2002): 3-40, particularly pp. 27-33. The surname Basque may reflect the presence of Basque whalers and cod fishers on the Gaspé peninsula since the time of Jacques Cartier or earlier. See M. Kurlansky, *Cod* (New York: Walker, 1997), pp. 21-29.

[16] W. E. Logan to James Logan, 2 June 1844, LP/MUA. On the elaborate and prolonged Canada-U.S. boundary dispute, see F. Carroll, *A good and wise measure* (Toronto: University of Toronto Press, 2001).

[17] For detailed lists of Logan's expenditures in the calendar year, which amounted to just over £800, see "Classified arrangement of expenses paid by W.E. Logan on account of the Geological Survey of Canada for 1844," box 1, Logan manuscripts, ESIC. This document shows, for example, that John Stevens received £10 per month from May to October, while John Basque obtained £5, and the other Indians £4 15s, as their monthly rates.

Cove, near the town of Gaspé, on the last day of May, they arrived at two o'clock in the morning. Going to the house of a captain Logan knew, they found him away; instead, the door was answered by his wife, awoken from her sleep. "She appeared before us in her chemise de nuit, barefooted, and as the Captain was not at home I am persuaded De Rottermond, if nobody else had been present, would have felt disposed to put his mesmeric arts into practise."[18] While the Count's putative behaviour might have been in some sense manly, it was not an inclination that Logan endorsed. Regardless of how far we can rely on the accuracy of Logan's impressions of any situation, what is important is how he chose to record it in his journal; how he chose to present it to himself as a means of critiquing and distancing himself from De Rottermund's brand of masculinity.[19]

Later, at the private house in which they were staying at Gaspé, as they readied their equipment for departure, De Rottermund got into a nasty dispute with the landlady over the poor quality and extravagant prices of her food. After he complained all week about the lack of fresh meat, she finally suggested him that "if he was so anxious to have fresh meat, he had better turn up his b---- and she would cut off a slice and roast it for him. This was a settler for him for though he did not understand the expression being a very imperfect English scholar, I translated it for him literally." De Rottermund called the landlady a "*vieille sorcière*" and insisted to Logan that they leave the house that day,

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[18] Logan, 1844 Journal, 31 May. On "mesmeric arts," see A. Winter, *Mesmerized* (Chicago: University of Chicago Press, 1998).

[19] While the general objection can be made that De Rottermund has no opportunity to defend himself from Logan's recorded version of events, Logan later hinted tantalizingly at another journal, one that would function as a counter-text to his own, though it was as out of reach for him as it is for us: "De Rottermond employs himself in writing his journal, which he keeps in the Polish language, I suppose that none of us should understand it if, by chance any of us should be prompted by an improper curiosity to look into it"; 19 July 1844.

saying that he would rather live in the woods, in their tent.[20] Although Logan was no great fan of Mrs Paddy, the landlady, he also realized that she ran the only house of lodging in town, and furthermore that his survey depended on local goodwill wherever it went. In the previous year, he had spent many months traveling up and down the Gaspé coast, meeting many of the inhabitants, and never getting into such an altercation with them. While De Rottermund might have been within his rights to complain impatiently about the quality of service he received, he was unpleasantly surprised when Mrs Paddy responded in kind, with abuse of her own. Rather than sharing De Rottermund's sentiment, Logan seems to have taken delight in facilitating this meeting of cultures, helping to ensure that the landlady's delicate nuances did not go unappreciated and that the Count got what he deserved.

If a masculine identity is often defined in terms of its opposites, such as femininity, then two masculinities can be contrasted by juxtaposing their dissimilar reflections in a common glass.[21] In this way, Logan recorded De Rottermund's treatment of the women they encountered as a way of showing that he, as director of the Survey, adhered to a different code, one that valued good social order over immediate personal gratification. As white men, moreover, Logan, De Rottermund, Murray, and Stevens were also defined by their race, in opposition to the "Indians" (with whom, incidentally, they did not share a tent). Thus, De Rottermund's treatment of the natives also came

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[20] Logan, 1844 Journal, 12 June. "Old witch" or "old hag." This passage serves as evidence that Logan and De Rottermund communicated in French.

[21] For a review of Victorian masculinity, see J. Tosh, "Masculinities in an industrializing society: Britain, 1800-1914," *Journal of British Studies* 44 (2005): 330-342. On gentlemanly honour codes as a way of policing who could be a scientist, see R. Nye, "Medicine and science as masculine 'fields of honor'," *Osiris* (2nd series) 12 (1997): 60-79.

under Logan's scrutiny: "One of the Indians already in my employment appears to have taken offence at some angry expression of Mr De Rottermond and has said if it were not for the advances that have been made him he would quit immediately."[22] Then, when in a rare occurrence one of the Indians, Peter, went missing and was later found "*drunk*," Logan was forced to make plans that accommodated the intemperance, so to speak, of both Peter and De Rottermund, eroding the distinctions between their troublesome behaviours and reinforcing his own role as the paternal guardian of all his men: "De Rottermond seems to have taken a great antipathy to the man, and as he is to be left here in charge of the tent while Murray, Stevens, and I go up the stream, I must take Peter with me to keep them separate, and to prevent Peter from again breaking his temperance pledge."[23] It would only emerge some six weeks later that De Rottermund had been surreptitiously paying some of the Indians on the side, to have them serve him personally.[24]

Logan, on the other hand, was more interested in the success of his mission than being waited on hand and foot. He thus instructed all his men, John Stevens, Michael the French-Canadian, and the Indians alike, to perform activities beneficial to the group as a whole: cutting firewood, preparing meals, stripping bark to make tent roofs and floors, hunting game, and navigating up the river and through the forests and hills. Frequent rains and high winds prevented the canoes from making progress along the coast; it took the party nearly a full month to work its way from Gaspé to the mouth of the Chatte River, which was to be their point of access into the interior. This was more than enough

[22] Logan, 1844 Journal, 17 June. That is, advances in pay.
[23] Logan, 1844 Journal, 19 June. Whether Peter was the same man who had threatened to quit before, or whether De Rottermund had made two different enemies, is not clear.
[24] Logan, 1844 Journal, 27 July. See the more detailed discussion of this incident below.

time for De Rottermund to realize that life in the woods was not superior to the town after all, as he had previously claimed at Mrs. Paddy's. His impatience and intolerance of camp life gave Logan frequent cause for worry, because he knew that greater trials lay ahead. When nothing more than smoke in his eyes and ashes in his food made De Rottermund complain that "really we were suffering too many hardships in the cause of science," Logan could "only think" of the steep, snow-capped, 4000-foot mountains they had yet to climb, while tramping mile after arduous mile through thick forests and dense undergrowth. Already De Rottermund had walked farther and worked harder than he had ever had in his life, and his mood was worsening daily, especially as their camp was regularly soaked by fierce storms. He appeared "decidedly tired of the expedition," and as the rising, rain-swollen river drove them from their tent in the middle of the night, he was "no doubt thinking himself very miserable."[25]

For Logan, however, it made no sense to forego "hardships" in the pursuit of scientific progress, because to him the two were one and the same. It was exactly because they were going where no surveyor had gone before that their work was valuable. It was entirely necessary to seek out and ascend the highest peaks, so that they could establish points of reference from which to fix the exact positions of regional topographic features. They had to force their way through the rugged interior in order to find out what rocks lay there, and how these were related to the ones which cropped out along the coast. In other words, the ability to climb mountains and cross wild terrain was central to Logan's science; hardship was not to be avoided, but embraced. His main fear was that De Rottermund's physical inadequacies would hold back the whole expedition.

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[25] Logan, 1844 Journal, 26 June, 28 June, 30 June.

Here in full bloom is the manly heroic ideal, identified by Oreskes as the core myth of science.[26] What is crucial to see, however, is that the identity of the man of science was actually not defined by the exclusion of women, but by criticism of other kinds of men. From the time they arrived in Gaspé to the beginning of their ascent of the Chatte River, Logan had used his journal to record those ways in which he and De Rottermund were different kinds of men, as indicated, for example, by their treatment of women and Indians. So far, though, De Rottermund's brand of masculinity had not caused rifts among the white men of the expedition. As they approached their first important goal, however, the stakes and the tensions rose, leading to a series of remarkable episodes that reveal the fundamental role gender played in the development of scientific exploration in the Canadian wilderness.[27]

The first objective of Logan's survey of the interior had been determined even before they set foot on the peninsula. Coming down the St Lawrence River from Québec, on the steamship *Unicorn*, Logan, Murray, and De Rottermund had stared appreciatively at the range of high hills that ran parallel to the river. These mountains, called the Chic-Chocs, were "reported to be the highest land in Canada," and to Logan they appeared "very formidable." His goal was simple: to plant a Union Jack on the summit of the "very highest peak."[28] In addition to the transparently imperial dimensions of this act, it

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[26] Oreskes, "Objectivity or heroism?," especially pp. 102-105. Oreskes sees heroism as merely ideology in modern science, because the risks taken by geologists in field work are "mostly exaggerated"; however it is worth pointing out that this was not always true in the past.
[27] An invaluable study of masculinity, wilderness travel, and the role of liminal passages in the British North American context is C. Podruchny, "Baptizing novices: ritual moments among French Canadian voyageurs in the Montreal fur trade, 1780-1821," *Canadian Historical Review* 83 (2002): 165-195.
[28] Logan, 1844 Journal, 31 May.

would also have real scientific utility. The flagstaff would be the highest object in the region, visible through their surveyor's telescope from every direction. Knowing the exact height of the pole from which their standard flew would allow them to gauge the distance to the peak when observing it from afar, using a new instrument Logan had brought along called a micrometer.[29] Because existing charts depicted only the peninsula's coastline, the surveyors would have to create their own topographic map of the interior in order to locate their geological observations precisely, which was in turn crucial to determining the complex stratigraphic structure of the place. Thus, the summit of the highest peak was the single most important geographical spot they would reach. From this commanding vantage point they would take compass bearings to all the surrounding landmarks, creating a reference framework from which they could triangulate their position as they moved through the unmapped interior hills.[30]

As a physical site, this summit was ripe for signification, but as a place it scarcely yet existed. The peak had not even so much as a name, a problem that Murray and De Rottermund (along with Captain Douglas of the *Unicorn*, supplier of the flag) proposed to remedy by christening it "Ben Logan."[31] Once it had been named, it could be put on a

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[29] This instrument (Rochon's micrometer telescope, an early form of optical rangefinder) was used extensively to generate accurate plans of the rivers they ascended and descended. For a detailed description of its use, see Logan, 1844 Journal, 11 July.

[30] See, for example, their attempts to locate the "Conical Hill," which was the most important landmark south of the Chic-Chocs Mountains. Logan, Journal, 12 August - 16 August, 1844. The surveying work and sections compiled in this summer's trip, as well as a few useful sketch maps and evocative illustrations, can be found in Logan, "Gaspé, Quebec" [1844], Field Notebooks 1965 and 1966, RG 45, LAC.

[31] Today known as Mont Logan, not to be confused with the much higher peak in Yukon, which was only named after Logan's death. Logan expressed his "disapprobation" of the plan to name the Gaspé summit for him (the Scots term in the proposed name suggests the idea was mainly Murray's), but his effort to register a protest was rather mild; Journal, 31 May 1844. (The highest peak in the Chic-Chocs is actually Mont Jacques-

map, and figure as an element in narratives, thus accruing a sense of place that would serve to anchor its status as the central topographical landmark.[32] The idea of planting the flag was so important that when John Basque accidentally left behind several items, including a bag of nails, he was sent back by himself to retrieve them, "as we shall probably want the latter in erecting our standard on the peak."[33] It was also crucial that they ascend the same summit that they had originally cast their eyes upon with Captain Douglas from the deck of the *Unicorn*, because it had been arranged that he would check that peak periodically with his own telescope as he plied up and down the St Lawrence. This external proof of their successful penetration into the interior would be an important validation of their accomplishment.[34] Proceeding up the Chatte River from the coast, Logan kept a close eye on his destination, watching for the peak as the canoes came around bend after bend on their winding journey between thickly forested banks.

But, when they finally began the long hike up to the summit from a camp on the river, Logan became concerned that Louis, their most experienced guide, was inadvertently leading them to the wrong peak. They reached the top without ceremony, only to confirm by compass readings and simple visual inspection that their true destination was a peak about a mile to the east, and clearly higher.[35] After spending a chilly night on this (literally) inferior summit, Logan sent all the men back to the canoes

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Cartier, but this is in the eastern part of the range, while the Survey party was in the west.)

[32] For a rich analysis of the "saturation" of landmarks with multiple types of significance, see D. G. Burnett, *Masters of all they surveyed* (Chicago: University of Chicago Press, 2000), ch. 4 and 5.

[33] Logan, 1844 Journal, 14 July.

[34] Burnett, *Masters of all they surveyed*, also discusses the function of imperial surveying landmarks as places from which to see and be seen simultaneously, pp. 129-30.

[35] Logan, 1844 Journal, 16 July.

in the morning, to fetch more provisions and establish a more suitably-located base camp, while he continued alone, believing he saw a way across a ridge to the peak from which his flag was meant to fly. In a few hours, "as tired as possible and as hungry as a hawk," Logan had reached the summit that was ever after to bear his name. He could not help but note that his very presence quickly changed the place, bringing life in the form of biting insects: "When I arrived at the summit there were no flies. But they soon came there upon me up the wind, which probably had carried to them an effluvia which told them there was something in the wind worth having."[36] Within minutes, according to Logan, nature's response intensified, presenting perilous danger: "Thunder clouds now began to show themselves ... and the thunder gave a threatening growl, which was sufficient intimation that I should be better off down below in the valley than on the bare stony mountain top without covering.... As I came down the side of the hill, there came a vivid flash of lightening and a quick and awful crash of a thunder clap right behind me. I am persuaded that the peak must have been struck. After this successive thunder peals roared among the mountain tops, giving us a salvo of heaven's artillery to welcome our arrival amidst the majestic scenery of Chique Choque."[37] Mount Logan had been born.[38]

Returning to the summit the next day, Logan and his men found it everything they had hoped for. They had a "grand day"; the prospect was "glorious," and they thought

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[36] This passage is further evidence of the centrality of sensation in Logan's experience of Gaspé; not only does the summit visit resonate with all of his senses, but his own presence there becomes a source of sense stimulation as well, as he posits that the flies have noticed him because of his scent.

[37] Logan, 1844 Journal, 17 July; also quoted in Harrington, *Life of Logan*, pp. 198-9.

[38] This rhetorical device of appropriating a place, while at the same time seeming to be entirely subject to it, resonates with Mary Louise Pratt's well-known concept of the "anti-conquest," a key technique of European scientific imperialism. M. L. Pratt, *Imperial eyes: travel writing and transculturation* (New York: Routledge, 1992).

they could see as far as New Brunswick. Logan recorded the powerful, commanding vista thus afforded by drawing a panoramic view of the surrounding mountains. Murray and Stevens "measured 63 angles to various peaks and if we can determine the distance to the next high western peak we shall fix a great many points in our forward journey"; in other words, this line would form the base of a surveying triangle). And they succeeded in getting the Union Jack up (adhering to the plan mentioned above) just as the *Unicorn* was passing on the St Lawrence far below, though Logan realized it might be some time before Captain Douglas saw it.[39] The summit was eminently successful in fulfilling its dual role as the anchor of their survey: it gave them the view of the land they sought going forward, and, unequivocally branded with their triumphant flag, it would give them a stable reference point to look back upon from the interior plateau. This was field science in full swing, and it was founded on Logan's lone heroic conquest of the peak. But if Logan's arrival had brought new meaning to the summit, the summit had also changed him, for the tensions brought to the surface by his successful leadership meant that the looming conflict between his way of doing science in the wilderness and De Rottermund's opposition to it could no longer be forestalled.

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[39] Logan, 1844 Journal, 18 July; Harrington, *Life of Logan*, pp. 199-200. (The reproduction of such material in Logan's official biography (1883) serves to reaffirm its status as definitive of his experience and accomplishments.) The entries in Logan's field notebook for this period are mainly concerned with barometric observations in order to estimate altitudes (Logan, FN 1965, entries for 16-19 July 1844), however, for an illustration of a similar panorama later in the expedition, see the pages around the entry for 30 August 1844.

4.3 Too Many Men in the Tent

In many respects, the camp and the summit were as different as night and day. If the mountain peak was elevated, open, and a place of limitless possibilities, then the white men's tent, down in the valley, was closed, dark, and claustrophobic; a place ripe for conflict to erupt.[40] At night, crowded into a leaky, sticky, spruce and birchbark wigwam that had been hurriedly constructed by John and Baptiste Basque, the difference in masculine styles between De Rottermund and the others could not be overlooked. For the first time, Logan explicitly faulted the Count's behaviour, instead of giving him the benefit of the doubt, or chalking the tension up to personality differences, as he had done earlier in the trip. If De Rottermund had been unhappy before, when they were coming along the coast and up the river, he was truly miserable now that they were deep into the woods: "Poor man he groans all night in his sleep and I am persuaded he thinks he is on this excursion suffering the pains of purgatory for his own sins and those of all his progenitors of antient and noble Polish blood."[41] Logan was unsympathetic, however, further noting that:

> De Rottermond seems to be the most uncomfortable among us, but instead of attributing his greater discomfort to some quality within himself, he seems to imagine that it always arises from something peculiar to his place in the tent. Either there is more smoke where he is than anywhere else, or the fire is farther from him than anybody else. Or the ground is wetter

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[40] The opposition of place between peaks and base camps is noted by K. Morin et al., "(Troubling) spaces of mountains and men: New Zealand's Mount Cook and Hermitage Lodge," *Social & Cultural Geography* 2 (2001): 117-39; in this case, however, the lodge provides a welcome respite from the deprivations of the mountain top, opposed to it in terms of comfort and security.
[41] Logan, 1844 Journal, 19 July.

> where he is, or there is some chink in the tent which lets in the wind where he is. Or the flies bite most where he is.[42]

From this point, De Rottermund's unsettling behaviour in the tent only escalated. After an incident two days later, John Stevens had to resort to staking down "a long pole between him and De Rottermond in the tent," because, as Logan recorded:

> last night De Rottermond woke him [Stevens] up by giving him a punch in his side and telling him that he was pushing up against him, informing him at the same time that '*you is your place and I is mine*'. Stevens pointed out to him that if they were touching it was because he [De Rottermund] had come out of his place, leaving space enough between me [Logan] and him for another person. His Countship is evidently in bad humour with the expedition altogether.

For his part, though, Logan remarked that "we have been very comfortable in our tent, at least I have."[43]

A more serious episode took place later that week, toward the end of July, while the party was making a side trip to locate the western peak they had seen from Mount Logan, which would be the other end of their surveying baseline. The distance to the mountain proved greater than expected, though, and once again they had to build

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[42] Logan, 1844 Journal, 17 July. Except for this passage (p. 199), Harrington's narrative of the expedition entirely effaces De Rottermund's role, literally "passing over" the crucial "interval of several weeks" (p. 200).

[43] Logan, 1844 Journal, 20 July. The text of De Rottermund's statement appears quite clearly to read "is," not "in"; this presumably reflects Logan's desire to record his difficulties with English. Two days later, while the others went out surveying, De Rottermund was left behind at the tent "to console himself as best he could with an English and French dictionary." Logan, 1844 Journal, 22 July. It also seems from this episode that De Rottermund slept between Logan and Stevens, possibly the warmest and driest spot in the tent.

temporary shelter for the night. This area had few trees and there was consequently a shortage of suitable bark from which to build a tent. As it began to rain yet again,

> De Rottermond who no doubt was very wet and cold like ourselves, took one of the pieces of bark and drying it before the fire placed it down under the middle of our sloping roof, and sat himself down to dry, taking off his boots and stockings and pulling on a dry pair of the latter. Thus making himself as comfortable as circumstances would permit, while Murray and I were left to content ourselves as we could in the rain, the ends of the wigwam being yet incomplete for want of bark, and the wind and wet blowing in upon the positions usually occupied by us, and no spruce boughs being yet on the ground.[44]

Furious with De Rottermund for his inconsiderate behaviour that bordered on insubordination, Logan attempted to defuse the situation and reestablish his authority as "Captain of the expedition" by making an elaborate ritual of their meagre meal that night. The dishes were arranged in front of him carefully, and he served with great formality the small pieces of salt pork and salt beef and the watery soup in which they had been boiled. Having learned to use food as a personal tool the previous year, Logan now attempted to deploy it as a means of social amelioration. Unfortunately, however, De Rottermund was not amused, and neither side forgot the incident.[45]

By now, Logan's criticism of De Rottermund was no longer restricted to his journal; instead, he challenged the Count openly about his scientific and political beliefs,

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[44] Logan, 1844 Journal, 27 July.
[45] Logan, 1844 Journal, 27 July. These events occurred on the 26th; the entry for the 27th is ten journal pages long.

and discussed with his assistants what a burden De Rottermund was likely to be.[46] And, now that the Count's behaviour had begun to inconvenience the group more seriously, Logan equated the De Rottermund's moodiness with that other great and uncontrollable obstacle, the weather, often writing that he was as "gloomy as thunder." Increasingly, it seemed that whenever other members of the party did something right, De Rottermund did something wrong. Thus, when John Stevens and Baptiste Basque managed to shoot a bear, they brought great honour to themselves. Logan was given the skin, and thought it would make a "fine ornament" for his sleigh, if he were to make geological excursions around Montreal in the winter.[47] De Rottermund was given the bear's skull, but when he tried to acquire another specimen from a different animal for his collection, he earned only Logan's derision for entirely obliterating a red squirrel with a shotgun, wasting powder and shot, and endangering the tent by firing too near to it.[48]

Logan and De Rottermund seemed to be opposed in every way. While Logan's surveying mission was a success, De Rottermund's objective of conducting chemical tests on the rocks had been a total failure, largely because the dense cover of vegetation had made finding suitable exposures very difficult.[49] As far as Logan could see, De Rottermund served no function: "he is of no use whatever on the expedition and I fear

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[46] See Logan's entry for 19 July on De Rottermund's belief in phrenology and animal magnetism, and 23 July for his support of tyranny over democracy.

[47] Logan, 1844 Journal, 19 July. See also William E. Logan to James Logan, 4 August 1844, LP/MUA. He asked his brother to buy him a small sleigh ("cariole") if there was a cheap one available, with harness.

[48] Logan, 1844 Journal, 25 July.

[49] The centrality of chemical analysis to geological surveying was generally accepted; for a good discussion, see B. Cohen, "Surveying nature: environmental dimensions of Virginia's first scientific survey, 1835-1842," *Environmental History* 11 (2006): 37-69.

this mortifies him."[50] This is not to say that De Rottermund was incompetent as a man of science. In a European court or academy, surrounded by the appropriate facilities and assistants, he was presumably capable of performing what passed for successful chemistry. But out here, in the woods, his attempt at such practice simply led to disaster. Science could not be practiced in Canada without a mastery of the accompanying physical and environmental experience, as Logan had learned the year before. Trying to make himself comfortable only earned De Rottermund the enmity of the rest of the party, and treating the Mi'kmaq guides and field men as his personal servants only made matters worse.

Late in July, while they were still away from their base camp, disaster struck the expedition. Louis, their principal and invaluable guide, fell gravely ill with a "violent inflammation of the lungs," and could hardly move. No one knew what to do, and with this added stress there was more work for everyone. It was not long before Murray, the assistant geologist, began shouting angrily at De Rottermund, who was standing around uselessly and distracting the Indians, rather than doing anything himself. De Rottermund "became very agitated," paced up and down muttering to himself in French, and then poured out his heart to Logan: "He said that we were all against him, and did not regard him as at first, that the tone Mr Murray has assumed in what he had said convinced him that it would be impossible for him to remain with us and that he would be obliged to me if I would find the means of returning him to the coast." While denying the general charges, Logan did not neglect to mention the tree bark that De Rottermund had taken

[50] Logan, 1844 Journal, 20 July. At this point, Logan did not doubt that De Rottermund was a competent chemist; all his criticisms of the man concerned his inability to live in the woods.

from their tent in the rain, or the punch he had given John Stevens in the night, or the more general problem that the Count monopolized the Indians' time with his personal needs. De Rottermund's reply could hardly have surprised Logan more:

> In explaining about Stevens he let out that he has all along been taking him for my "*domestique*" [servant] and ... that he must have treated Stevens most grievously ill on more occasions than one. I asked him how he came to suppose if he looked upon Stevens as my "*domestique*" that I would treat him in the way that I did as a friend rather than anything else, eating with him, sleeping alongside him, etc. He said he had conceived it to arise from the freedom of American manners. In his explanations he let out also that he had at the commencement of the expedition informed Frank that if would be especially attentive to him that he would give him separate pay.[51]

It thus turned out that De Rottermund's sharply divergent notion of how a man should behave in the bush was at the root of the expedition's internal turmoil. No adherent of social equality, the Count apparently found it easier to believe that the Director of the Geological Survey of Canada would casually treat his serving-man as a friend, than to believe that such a gentleman could have a genuine and equal friendship with someone so much lower in the social order. Logan carefully explained that although John Stevens's manners were not refined, he was nevertheless a person of consequence within his own milieu, being the son of a major mining proprietor. Even worse than this error, though, was De Rottermund's treatment of the Indians as his own personal

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[51] Logan, 1844 Journal, 27 July. Louis eventually recovered, after having more than a pint of blood removed in the field by an intrepid Logan and his well-meaning associates. They also administered a blister and a wide range of purgatives in pursuit of their cure.

servants, which struck at the heart of what Logan was trying to achieve: not material comfort, but the conquest of new terrain. Logan explained carefully that there was a direct correlation between De Rottermund's selfish behaviour and the other explorers' well-being, particularly the state of their clothes:

> The Indians had at first refused to wash for Murray and Stevens and it was not until I interposed my command in a serious way that they would do it and they did it sulkily. Now I found that their reason for refusing was the expectation of extorting pay from Stevens and Murray such as they got from De Rottermond. I had supposed their unwillingness to arise from a disinclination to the performance of a description of work they were not accustomed to and one which they considered as properly belonging to the department of the squaw kind. While I had forced them to wash for Murray and Stevens I had at the same time abstained from giving them my own clothes and in order to set Murray and Stevens an example without however saying anything to them, I had washed them myself, when they had been washed, which however had only been once and not having time to wash them oftener I had carried them on my back dirty, having changed only once from the time we had left from Gaspe.[52]

In other words, Logan had taken the Indians' reluctance to do laundry as a reflection of their beliefs of what a man's work was; chastised, he resolved to follow this code

[52] Logan, 1844 Journal, 27 July.

himself.[53] To avoid having the subordinate men under his command do women's work, Logan resolved he should so it for himself, if it was to be done at all. In reality, though, the Indians' behaviour had been governed by De Rottermund's class and gender identity, which said that a gentleman should not do menial work for himself, but pay lesser men to do it for him. The upshot of all this was that Logan's clothes were in very poor condition, but that this served as a visual testament to his principled moral stance.[54]

In fact, of all the distinctions that Logan and his friends made between themselves and De Rottermund, none were pursued as thoroughly as than those pertaining to vanity about personal appearance. Logan prided himself on wearing nothing but strictly utilitarian clothing, recording that, "I purchased 3 red flannel shirts in Montreal and mean to wear nothing else all the time I am out. My working dress will consist of moleskin jacket, waistcoat and trousers; a white broad brimmed hat of strong felt; Welsh boots, worsted stockings and flannel drawers. No linen or cotton shirt."[55] When conditions demanded it, such as on top of a mountain at night, he simply added more layers, reversing the convention of disrobing to sleep: "I have put on two flannel shirts and 2 pairs of stockings so that to go to bed instead of undressing I put on all the clothes I have."[56] De Rottermund, on the other hand, believed in a way that made sense in polite society, but no sense at all in the wilderness:

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[53] Logan, 1844 Journal, 8 July: "I have changed my flannel shirt and drawers for the first time since I left Gaspé, and I have washed them myself into the bargain. I dare say I shall not effect another change until I get across to Bay Chaleur."
[54] For future research on the philosophy of clothes in general, or on what such a philosophy might imply, it would be worth considering Thomas Carlyle's *Sartor resartus* (1833-34), a widely-read and influential text in the early Victorian era.
[55] Logan, 1844 Journal, 31 May.
[56] Logan, 1844 Journal, 16 July.

> De Rottermond has been groaning all night and this morning he complains of having been very cold. But deuce take him instead of complaining why does he not take means to remedy deficiencies as well as he can. Like a silly fellow he seems to have a horror of sleeping in his trousers. So he takes them off when he draws his sack on and then complains of the cold. I dare say I should been cold had I not had all my clothes on. Three pairs of stockings on my feet, and over my trousers about my knees a flannel shirt. I slept as comfortably as a man could.[57]

If De Rottermund was uncomfortable, Logan implied, it was because he was not very good at being "a man," at least not the kind that life in the field demanded. And if De Rottermund insisted on having clean, well-kept clothes, wasting the Indians' time to such ends, then Logan, Murray, and Stevens could not resist the temptation to distance themselves from him by embracing the opposite behaviour, and revelling in their sartorial disarray: "We are getting into rather a ragged condition. I have three holes torn in the left knee of my trousers and Murray has a large and broad strip quite out of an unmentionable part of his." To care about one's appearance would be to act like the Count, and that was unthinkable:

> De Rottermond who is a bit of a dandy even in the woods manages to keep himself rather neat, but then he has nothing to do and does nothing.... He has a small hair brush with him, with a looking glass in the back of it and he admires his beard in it every morning. He has a couple of ribbands to his broad brimmed round topped hat and he has two or three manners of

[57] Logan, 1844 Journal, 18 July.

> tying it. Sometimes he has the sides under his chin and then his hat looks something like a bonnet and sometimes the tie is over the crown and then it looks like a cocked hat. Murray and Stevens call him the old lady, by way of sobriquet among themselves.[58]

Ironically, then, just as De Rottermund had dismissed Mrs Paddy the landlady as a cranky old woman (*vieille sorcière*), and beneath his contempt, the other men in his party now defined their own masculinity by distancing themselves from De Rottermund himself in very similar terms, reducing him to the category of "the old lady."[59]

De Rottermund, as it turned out, did not last much longer with the expedition. A few days after the worst altercation, he developed a severely inflamed big toe, and had to be sent back to civilization.[60] Logan expressed concern that he would have to wear his field clothes all the way back to Québec, but luckily for the Count he was able to retrieve some of his baggage that had been left behind on the coast. The rest of the surveying party continued on foot across the interior to the Cascapedia River, which they descended in spruce bark canoes assembled on the spot by John and Baptiste Basque, a now-recovered Louis, and Michel the French Canadian. Descending the river, they reemerged into civilization early in September, surprising a few locals, for no one before had come down this route who had not first gone up it. Logan's description of his appearance by this point (quoted below with all textual revisions intact) represents the epitome of a

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[58] Logan, 1844 Journal, 20 July.
[59] Pratt argues that the sentimental, private European traveller and the disinterested scientific explorer are but two sides of the same non-heroic coin; what is interesting is that Logan was able to make use of both identities in his Journal, by inhabiting one himself, and his creating its opposite, "De Rottermond," to embody the other. Pratt, *Imperial eyes*, p. 78.
[60] Logan, 1844 Journal, 3 August, 4 August, 7 August.

masculinity that scorns the cultivation of superficial details, disregarding all such niceties in the name of the higher pursuit of science:

> A hole has been born in the right knee of my trousers last night. We are all pretty figures. I fancy I cut the nearest resemblance to a scarecrow. What with ^hair matted with spruce gum^ a beard 3 months old, red with 2 patches of white on one side, a pair of cracked spectacles ~~trousers pate~~ a red flannel shirt, a waist coat with patches in the left pocket, where some sulphuric acid which I carry in a small vial to try for the presence of lime in the rocks leaked through and dissolved the cloth, a jacket of moleskin shining with grease and trousers patched on one knee in 4 places and a burnt hole in the other, with beef boots, Canada boots as they are called, torn and roughened all over with scraping on the stumps and branches of trees and patched on the legs with sundry pieces of leather of divers colours and a broad brimmed and round topped hat ^once white but now no colour^ battered into all shapes, ~~and hair matted with spruce gum~~.[61]

On closer inspection, though, this passage contradicts the idea of careless neglect that it purports to express. For here is Logan editing his own words as he writes, rearranging them for maximum effect, preeminently concerned with creating a particular image of

[61] Logan, 1844 Journal, 5 September. I have generally suppressed similar textual emendations elsewhere, supplying instead a clear-text version for ease of reading. But this practice of editing "on the fly" was not uncommon for Logan, who wrote for literary effect in his Journal (though I have found no particular evidence that he intended it for any reader but himself).

himself as a scarecrow.[62] He is anxious to record what kind of summer he had in the field, and how he lived while doing it: not like a dandy, not like an old lady, but like a man on a relentless quest for facts.

A scarecrow, however, is not a man: it is an effigy of a man, an artificial exaggeration designed to fulfill a specific purpose.[63] The reaction of Mrs Barton, the Scotswoman at whose house they first stopped on their way down the Cascapedia, suggests that Logan's appearance really was unusual to the point of exaggeration. Or, since this is how he chose to record it, that he wished to believe so: "With all these adornments, I am not surprised that Mrs Barton, speaking of her children, and saying that here was a little fellow frightened at nothing on *earth*, should qualify her expression by saying 'but I think he is a little scared at *you*, Sir.' She said although she was accustomed to people from the bush, she did not know what to make of us."[64] As such, we can read Logan's 1844 journal of his geological survey in Gaspé as a text about what role a certain kind of masculinity should play in scientific exploration. The scarecrow image represents that ideal, designed to ward off any questions about the explorer's sincerity, dedication, and credibility. In this sense, it was of a piece with the wild food he had eaten and pains he had suffered the year before, that he had been so keen to spread the word about, so that his seriousness might not be doubted. Logan's masculine identity

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[62] The jacket pocket, patched where acid had burned through, might be read as a nice reference to De Rottermund's absence, and to Logan's taking over the chemist's job, thus patching the hole in the surveying party left by his departure.

[63] For a related idea, see Burnett, *Masters of all they surveyed*, p. 252. Here a scarecrow was literally manufactured and left behind in the field as a warden.

[64] Logan, 1844 Journal, 5 September. This note holds true about every word of the journal: it is not what "actually happened"; it is what Logan chose to record and how he chose to phrase it.

was thus to a significant degree made in the bush, in dynamic negotiation with the other kinds of men he encountered there, De Rottermund and the "Indians."[65]

Logan's relationship with the actual De Rottermund, the one whose departure proved that there really had been too many men in the tent, did not end in Gaspé. Despite his opinion of the Count as an explorer, Logan remained under the impression that De Rottermund was a competent chemist, and participated happily in the younger man's wedding the following spring, telling him that the event "tended greatly to augment my esteem for you."[66] The Count's persona proved as chimerical as ever, though, and one year later they were at odds again over the fact that De Rottermund had been drawing a salary from the Survey for some time, without having produced any identifiable results. On this occasion, the Governor-General was obliged to request copies of their agonistic correspondence and publish it in the *Journals* of the Legislative Assembly of the Province of Canada, as a matter of public record.[67]

More successful, perhaps, was the career of the other De Rottermund, the textual creature who never really left the field, but remained as an idea against which Logan

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[65] For more on the specific theme of competing masculinities as expressed in exploration narratives, see for example L. Bloom, "Science and writing; two national narratives of failure," in T. Lenoir, ed., *Inscribing science* (Stanford, CA: Stanford University Press, 1998), 328-350; P. Hansen, "Confetti of empire: the conquest of Everest in Nepal, India, Britain, and New Zealand," *Comparative Study of History and Society* 42 (2000): 307-332; and G. Myers, "Colonial geography and masculinity in Eric Dutton's *Kenya Mountain*," *Gender, Place and Culture* 9 (2002): 23-38.
[66] Logan to De Rottermund (draft), 17 May 1845, LP/MUA. See also 1844 Journal, 19 July: "My friend knows chemistry very well I do believe." Of course, the wedding served to differentiate the men even further, as Logan never displayed much interest in women or family life, and scarcely had time for either, between unbroken months in the field and endless late nights at the office in the winter.
[67] JLA 1846, Appendix WW. Reprinted with additional material as *Report and critiques of E. S. de Rottermund, Esq., late chemical assistant to the Geological Survey of Canada* (Montreal, 1850). Logan and De Rottermund were to clash several more times before the latter's return to Europe and eventual demise; see also chapter 5 below.

defined himself, in the form of a scarecrow. This metaphor might be of restricted significance had it remained confined to Logan's journal, finding few if any later readers. But, in perhaps the most surprising aspect of the whole story, Logan's scarecrow and the masculine identity it embodies have been remarkably persistent. This is because the key passage from Logan's journal was quoted by Robert Bell, a geologist of the Survey's second generation, in his widely read and deeply influential pamphlet on Logan's personality and habits.[68] Bell's pamphlet was published around 1910, just as Alice Wilson's career was getting underway at the Geological Survey of Canada. It promulgated a particularly romantic view of Logan as a singularly dedicated servant of geology, "wedded to the rocks," habitually working late into the night and so unconcerned with worldly matters that he was sometimes taken for a lunatic, wandering in the field in ragged old clothes.[69] In short, this was just the image of the self-sacrificing scientific hero that Oreskes claims rendered women's scientific work virtually invisible, and their participation in the field impossible.

Oreskes also argues that this "cliché" of lonely, isolated toil still pervades the image of science today, and this is borne out in the case of Logan as scarecrow.[70] Visitors to the website of the Geological Survey of Canada in the early twenty-first century (2001-2007) have found a special page dedicated to the founder of one of the federal government's most important research institutions, his picture displayed next to a

[68] R. Bell, *Sir William E. Logan and Geological Survey of Canada* (Ottawa, [1910]), p. 8. This has been the source of many further quotations of the scarecrow image, e.g., Zeller, *Inventing Canada*, p. 62.
[69] Bell, *Logan*, p. 23.
[70] Oreskes, "Objectivity or heroism?," pp. 110-112. Marianne Ainley similarly concludes that Canadian geology's "old associations of masculinity and rugged outdoor activity" meant that women "rarely work in the field." Ainley, "Women's work in geology," p. 141.

list of memorials, all capped by that enduring phrase, "I fancy I cut the nearest resemblance to a scarecrow..."[71] A long quotation in Logan's own carefully-edited words is reproduced. Canada is the kind of place, it effectively says, where geological field work requires heroic bodily sacrifice; without suffering there can be no science. This then is a crucial part of the history of masculinity in Canadian geology: the image of the scarecrow is officially endorsed today, was reprinted in the early twentieth-century as an exemplar, and was written down in a journal one evening on the Gaspé peninsula in September 1844, as a rebuke to one who would value clothing and comfort over scientific achievement. Logan's scarecrow thus patrols a gender boundary that determines who can practice geology in the Canadian field. And so, in the specific case of Alice Wilson, who was ruled in 1926 to be "sexually ... not fitted" to work in the field, the delimitation of a woman's career can be traced back to 1844, and to the conflict between two competing versions of masculinity in the high hills of the Gaspé peninsula.

Finally, we can affirm that this particular association of Logan with masculine science was actively perpetuated by those who charged themselves with guarding and promoting his memory: the exploring geologist Robert Bell, Logan Club instigator Andrew C. Lawson, and of course Logan's official biographer, Benjamin Harrington, who more than any other author was responsible for the image of Logan as an indefatigable adventurer, as it has come down to us today. All of these men were GSC employees, and even as they varied in their professional approaches and outlooks, they shared a common goal of consolidating Logan's status at the close of the nineteenth

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[71] http://gsc.nrcan.gc.ca/hist/logan/index_e.php. (19 December 2006).

century, in the generation after his death, and just as the Survey was beginning to hit its stride.

Thus, at the Logan Club's first annual symposium in December 1888, a young geologist named Andrew Lawson (in fact, the first Survey employee to earn a Ph.D.) presented his light-hearted but enormously successful poem "Mente et Malleo," which encapsulated the field life of the geological brotherhood.[72] His phrase "a jollier crowd you'll rarely find,/ Than the men who chip at earth's old rind,/ And often wear a patched behind" hearkened back directly to Logan's attention to his clothes, the possibility of embarrassing (so to speak) disclosure, and above all the importance of patches, which of course were constitutive of Logan's scarecrow image. All this Lawson contrasted completely with the other form of masculinity, imagined in what Lawson called "the other fellow," who was cosmopolitan, dainty, and not at all disdainful of the opposite sex: "But no maiden fair to our arm doth cling;/ She, at Ottawa, with smiling lips,/ The other fellow's ice cream sips." This other fellow, one might say, was clearly a descendant of the Count de Rottermund.

In the case of Logan – who, like his brothers, never married and for whom no female relationships outside of those with his mother and sisters are known – there is also anecdotal evidence of his rejection of women. Robert Bell, whose primary contributions to Logan historiography were the well-known stories of Logan being taken for a lunatic by uncomprehending locals, also related several incidents to underscore Logan's "confirmed bachelor" status. Thus, faced with the recurring question of why he had not

[72] F. Vaughan, *Andrew C. Lawson: scientist, teacher, philosopher* (Glendale, CA: A. H. Clark, 1970). See also F. J. Alcock, *A century in the history of the Geological Survey of Canada* (Ottawa: National Museum of Canada, 1947), p. 94; and "Logan Club history," http://gsc.nrcan.gc.ca/hist/logan/loganclub_e.php (19 December 2006).

yet taken a wife, "To one lady who had attractive daughters he said … 'I am already wedded to the rocks.' To another he answered: 'It would take up too much of my time. I really have not the time to spare. Other rocks than "rock the cradle" claim my whole attention.'"[73] In other cases, there were unfortunate tales of housekeepers discarding rock specimens carefully gathered by Logan in the course of a summer's travels. Perhaps most intriguing, though, is the story of a tavern girl who wrote "a lot of love verses of her own composition all over the face of his map-sheets" while he was away in the field. Bell explained (or conjectured) that:

> It was not the girl's sentiments themselves that annoyed him so much as the spoiling of the beautiful original maps on which he had spent many a night's labor. She had use pen and ink in her literary efforts and, of course, Logan did not care to file them among the records of the Department with such permanent ungeological notes scrawled all over them in a woman's hand-writing.[74]

This episode bears witness to how difficult it was to imagine a positive role for a woman in the nineteenth-century Geological Survey. For Bell, the twin facts that the verses were ungeological and that they were in a woman's handwriting were apparently of equal

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[73] Bell, *Logan*, p. 23. Although this pamphlet was not published until c. 1910, it was closely based on a lecture given by Bell in 1885. See "Personal reminiscences of Sir William Logan," box 2, Robert Bell Papers, MG29 B15, LAC.

[74] Bell, *Logan*, pp. 24-25. It must be admitted that it is impossible to verify Bell's story, or the particular reading he made of it. These are recurring issues with Bell's biographical work on Logan because Bell, who in his exploration style resembled more closely Logan than he did the geologists of his own time, can be seen as employing a somewhat slanted view of Logan's heritage in pressing his own case in a series of bitter disputes with the government about Survey leadership.

weight, and perhaps thus even tacitly equated, in explaining why the altered maps were necessarily excluded from the official records.[75]

In the end, we can close with a final example of how Logan conceived of his geology and his gender as inextricably related. Preserved among Robert Bell's scraps of biographical notes on Logan is an anecdote according to which the long-serving butler Michael, folding Logan's trousers one day, "found some small rock specimens in the pockets & taking them to Sir William said he had found these in his inside pockets a strange place for stones to be." Logan's reply, apparently, was "Where should a man's stones be, but inside his trousers?"[76] This remark functions at once as a joke and as a sincere insight. Logan's "stones," in the reproductive sense, were geological, not biological; he projected himself instead as wedded to the rocks, and sought no "maiden fair." In doing so, he established a model of Canadian field geology that I would describe as both positive and negative. For all that it enabled, it also limited, in circumscribing the possible identities of the exploring surveyor. In this sense, the tendency to celebrate Logan's life and accomplishments, laudable as it is and as they are, might also be recognized as contributing to the reproduction of a certain gender asymmetry in field geology. As long as that remains a current issue for women in science, it would be well to adopt a more measured view of Logan's biography, one that appreciates just how central his particular masculine identity was to his work.

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[75] Technically, the notes' inky permanence should be accorded equal status as a third explanatory factor. Also, Bell probably did not consider the case of what Logan would have done had the "love verses" not been in a woman's handwriting.

[76] Loose sheet, folder 38.5, "GSC Directors – Sir William Logan," box 38, Bell Papers, LAC.

CHAPTER 5

Writing the Rocks

In this chapter and the next, we move from the question of how scientific knowledge was produced in the field to the issue of how it was presented and consumed in the public realm. (In truth, the acts of representation and appropriation are also equally part of the overall process of production of "fact," but it is convenient for the purposes of discussion to make such a division into two phases.) This chapter examines the reworking of field experience into textual and visual/material forms, with the ultimate goal of creating finished knowledge products that could be absorbed at a glance. In William Logan's case, the person of the individual field scientist was no less important to this second, representational stage, because he wrote the reports and arranged the mineral displays with his own hands. A Canadian geologist's career alternated between summers in the field and winters in the office or museum, a pattern that Logan followed during the 1840s and for much of the 1850s. In this sense, Logan himself was the site through which field experience was reworked into scientific fact. He began with a medium that he detested, and would have preferred to avoid: annual reports.

5.1 'I wish these annual reports were at the devil'[1]

In 1841, when the Legislative Assembly of the newly-created Province of Canada had approved the funds for a geological survey, it had every reason to believe that the project

[1] An earlier version of this section was circulated on the "History of the Book in Canada" website at http://www.hbic.library.utoronto.ca/vol2shipley_en.htm

would be completed within in a fixed amount of time, on a fixed budget. After all, many of the American states had conducted their own geological and natural history surveys in the 1830s, and had seen results produced with a reasonable degree of expediency.[2] Canadian legislators could not have foreseen that they were initiating a national institution that would continue to the present day. What had worked in the United States ought to work in Canada, too. In order to reassure those who were skeptical about the utility of geological science, and to ensure accountability for the expenditure of public funds, it was standard practice in the U.S. for legislatures to demand annual reports from their state geologists. Naturally, then, the Canadian government felt that it had a right to expect regular accounts of progress from their newly-appointed provincial geologist.[3]

Logan's previous experience with the Geological Survey of Great Britain had differed in several important ways from American surveys. Because the science of geology (in its stratigraphic systems) was more highly developed in Britain, and because more precise topographical maps were available there, the work of the British survey was slower and more painstaking than U.S. work, which often had the character of a rapid reconnaissance. A lover of fine details, Logan had established his scientific reputation by making very sophisticated and exact maps of the coal fields near his home in Swansea, South Wales. One of the main challenges that he would face in his new position was the reconciliation of this time-consuming style of British geological mapping with the

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[2] On legislatures' expectations in the cases of New York and Virginia, see M. Aldrich & A. Leviton, "William Barton Rogers and the Virginia Geological Survey, 1835-1842," in J. Corgan, ed., *The geological sciences in the antebellum South* (University, AL: University of Alabama Press, 1982), 83-104; M. Aldrich, *New York State Natural History Survey, 1836-1842* (Ithaca, NY: Paleontological Research Institution, 2000); and B. Cohen, "Surveying nature: environmental dimensions of Virginia's first scientific survey, 1835-1842," *Environmental History* 11 (2006): 37-69.

[3] Logan reported to R. W. Rawson, the Civil Secretary.

practical conditions of doing geology in Canada, where scientific resources were few, accurate maps scarce, and the public impatient for useful results. The use of annual reports, which would require Logan to state his conclusions very early on in his investigations, was completely at odds with the British style of science, in which results were made public only after an extensive process of data collection and analysis.

Upon taking up his position as director of the Canadian geological survey, Logan wrote officially to his British counterpart and mentor, H. T. De la Beche. In the hopes of convincing the Canadian government to adopt the British rather than the American perspective on scientific publications, Logan asked De la Beche to comment on why it was inappropriate to expect annual reports from a properly-conducted geological survey. Logan explained that he was "especially anxious to bring the investigations to a conclusion in as short a time as a due regard to Geological truth ... will permit," but that "the main object of the investigation is no doubt to determine [the Province of Canada's] mineral riches, and it is not unlikely that a wish may be felt to know the result or the probabilities of the Survey long before it can possibly be completed. To meet a desire of this description in those states of the American union in which geological surveys have been undertaken, resort has been had to a system of Annual Reports. The example thus given may by some be considered to afford the best mode of making known the progress of the work. But the system appears to me objectionable for many reasons."[4]

Nevertheless, Logan found the need to report to his political masters inescapable. He soon realized that his observations would be published, whether he liked it or not: in 1845, he was alarmed to find that his preliminary correspondence with the Civil Secretary

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[4] Logan to De la Beche, 24 April 1843, DBP.

(dating back three years) had been forwarded by Governor-General Metcalfe to the Legislative Assembly, and printed as a government publication, in both official languages, for all to see.[5] By default, the Geological Survey of Canada had just published its first Report of Progress, much to Logan's chagrin. In forwarding a copy to De la Beche (Director of the Geological Survey of Great Britain), Logan apologized for the disorganized nature of the document, explaining that it really consisted of three separate reports, some written "before I knew anything of the subject," and with a substantial degree of internal repetition. "In my mind they have a very awkward appearance," he moaned, proclaiming, "I wish these annual reports were at the devil. But it is the fashion on this side of the Atlantic and I cannot help myself."[6]

Indeed, Logan had already discovered that annual reports of progress were inevitable if funding for the survey was to continue. After two years of field work, he and his assistant (Alexander Murray) had only established the broadest outlines of Canadian geology, and even to accomplish that had cost Logan £800 of his own money over and above the £1500 initially granted. Logan was encouraged by legislators to draw up an Act for the continuation of the survey, which he did, but one of the conditions was that progress had to be reported annually. "I should have liked very much to have left out the annual report, but I found it would not do. So I must be as cautious as I can on that score," Logan wrote.[7] Given this imperative to publish his findings every year, Logan had to devise a genre of report that would satisfy both his own scientific standards and the public desire for immediate, visible results.

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[5] RP 1843.
[6] Logan to De la Beche, 27 December 1845, DBP.
[7] Logan to De la Beche, 12 May 1845, DBP.

In his first report, Logan had erred too much on the side of caution, giving only the briefest hints about his four months of fieldwork in the summer of 1843. The problem was that Canadian geology was largely unknown, and a great deal of work was required to reach conclusions about how rock formations in complicated areas like the Gaspé peninsula matched up with the already established stratigraphy of Britain and the U.S. To do this required more than merely glancing at the Canadian rocks: their extent had to be correlated over exceeding large areas of uncharted wilderness, their fossils needed to be identified, and their minerals required chemical analysis. Many American state surveys had solved such problems by devising their own classifications of rock formations, caring little how these corresponded to European systems. Such parochialism was unacceptable to Logan, however, and in any case was gradually disappearing in the U.S. as geology became more sophisticated in its second generation.

In his quest to develop a suitable genre of scientific publication for his annual reports, Logan could only learn a limited amount from his British and American peers. The memoirs of the Geological Survey of Great Britain emerged slowly and infrequently, as massive monographs replete with extensive, fully-digested observations.[8] And while U.S. surveys did, of course, make use of annual reports, these were generally designed as merely temporary documents, to be replaced by a final report when the survey was complete after a period of three to five years. This approach was best exemplified by the four-man team responsible for surveying the state of New York, the geology of which

[8] De la Beche's first formal publication as Director of the British Survey took almost ten years to appear, and was nearly 300 pages long: H. De la Beche, "On the formation of the rocks of South Wales and South Western England," *Memoirs of the Geological Survey of Great Britain* 1 (1846): 1-296. See also E. Bailey, *Geological Survey of Great Britain* (London: Thomas Murby, 1952); and J. Flett, *The first hundred years of the Geological Survey of Great Britain* (London: HMSO, 1937).

was very similar to that of the southern, agricultural portion of Canada West (southern Ontario).[9] Although Logan consulted such works while forming his own ideas of what the Canadian survey should be, he ultimately had to find a structure that reflected his own priorities, and the needs and limitations of the Canadian context.[10]

As it happened, Logan was able to reach a satisfactory solution relatively quickly, beginning with his third annual Report of Progress, which covered his 1845 expedition up the Ottawa River; written by Logan in 1846, it was printed by the Legislature in 1847.[11] In this report, Logan pioneered a three-part descriptive structure that was to serve him well for many years to come. The first section dealt with geography and topography, and was essentially a narrative account of the field exploration undertaken by Logan and his party (which on this occasion included an actual Crown Lands surveyor). Told from the point of view of the explorers, this section introduced the general structure of the terrain, and commented on important natural features such as timber, waterways, and land potentially fit for agriculture. (To a certain extent, this approach foreshadowed the

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[9] The Natural History Survey of New York, 1836-40, published the four-volume *Geology of New York* (Albany, 1842-43), running over two thousand pages, not including plates and maps. James Hall's contribution to this series, vol. IV, is usually seen as the highest accomplishment in U.S. state geological surveys in this era, and Hall eventually became Logan's principal American collaborator. For background, see Aldrich, *New York State Natural History Survey*. For Logan and Hall's scientific relationship, including its later controversies, see W. Eagan, "'I would have sworn my life on your interpretation': James Hall, Sir William Logan and the 'Quebec group'," *Earth Sciences History* 6 (1987): 47-60.

[10] Logan's notes on some of the early annual reports of the N.Y. survey can be found in the back of his field notebook for his first year: W. Logan, Fieldbook 1964, "Gaspé 1843," RG 45, vol. 177, National Archives of Canada. For the contents of Logan's personal library (now held at the GSC's Earth Sciences Information Centre), including the publications of various North American and European surveys, see http://www.nrcan.gc.ca/ess/esic/llf_collection_e.html

[11] RP 1845. Appendices in this format were unpaginated until the Report for 1850-1851 (published 1852). On the Ottawa River expedition, see Smith and Dyck edition of Logan's 1845 journal, forthcoming.

eventual expansion of the Survey to include natural history in general, in the generation after Logan's directorship.) Logan also took pains to emphasize the topographical value of his surveying, in helping to make the country more accessible for development, even in those cases where no valuable minerals were found.

In the second section of his report, Logan addressed the stratigraphical sequence of rock formations encountered, from oldest (lowest) to youngest (highest). This was the main object of geological surveying: the elucidation of age, structure, and history of a region, and the correlation of its strata with their counterparts of the same era worldwide. ("Systems," that is, sequences from a specific geological time period such as the Cambrian, Silurian, and Devonian, were among the major concerns of British geologists at the time). Here, Logan put his highly-developed descriptive skills to work, providing extensive details of the exact composition and location of each formation. At this early stage in the Survey's work, however, he did not commit himself to a firm interpretation of their exact place in a comprehensive system.

Finally, in the third section, Logan devoted considerable attention to "materials capable of economic application." He was equally meticulous and exhaustive in listing these, and he made good use of his previous industrial experience as manager of a copper smelting works in South Wales, explaining not only where these valuable rocks and minerals could be found, but how they were processed, the uses to which they were put, and the potential domestic and international markets for them. Logan went one step beyond his American models such as the reports of the New York geological survey. These had approached their subject geographically, on a county by county basis, which led to a great deal of repetition and made it difficult to see the larger picture.[12] Logan, however, invariably arranged the economic section of his reports according to a technical classification of rocks and minerals. This included various metals and their ores; minerals used in chemical manufacturing, in agriculture, and as pigments; combustible and carbonaceous minerals; refractory materials, and materials used to make bricks, pottery, glass, cements, and mortars; grinding and polishing stones; building materials and materials for ornamental purposes; and lithographic stones.[13] In this manner, Logan was able to suggest not only the geological but also the industrial potential of the colony.

Using this tripartite style of annual report, Logan was able to convince readers that significant work was being undertaken, while laying the groundwork for his own future scientific conclusions about the true identity of the formations he had so carefully mapped. It is significant that each of Logan's three descriptive sections approached the land from a fundamentally different perspective. The first, geographical, saw the environment as a traveller in the present would, moving from point to point along the surface. The second, stratigraphical, understood the landscape as a fundamentally historical phenomenon, created over long periods of time by the deposition, contortion, and erosion of successive layers of rock. While necessarily more abstract, this view held out the prospect of integrating Canadian formations into international geological systems. Finally, the third perspective looked not to the distant past, or to the present, but to the

[12] See, for the clearest example, New York State Natural History Survey (James Hall), *Geology of New York*, vol. IV (Albany, 1843), chap. XXII, "Local geology and economic products," 414-499. Hall mentions that this information was largely compiled directly from the annual reports of the N.Y. survey.
[13] Adapted from the list given in Geological Survey of Canada, *Geology of Canada, Report of Progress from its commencement to 1863* (Montreal, 1863), chap. 21.

future, to Canada's economic potential and the wide range of industries it would one day sustain.

There is no question that Logan's strategic use of annual Reports of Progress was in many respects successful as the Survey progressed. They struck a happy balance between their very different British and American precedents, and at the same time reached out to readers with a multi-pronged approach that campaigned on several fronts at once.[14] The average length of the reports doubled from thirty or forty pages a year in the mid-1840s, to a 280-page omnibus edition covering the years 1853-56; beginning with the 1852 edition, a single-column layout replaced the old two-column style, and internal page numbers were included.[15] In addition to Logan's own reports, each volume contained increasingly sophisticated contributions from other Survey officers, such as assistant geologist Alexander Murray and chemist T. Sterry Hunt.[16] The periodic

[14] A valuable point of comparison is the close reading of strategies of data representation in Canadian government reports (using the case of the Education Department) in B. Curtis, "Textual economies and the presentation of textual material: charts, tables, and texts in 19th century public education," *Scientia Canadensis* 29 (2006): 3-28. For a completely different perspective on Logan's reports, emphasizing their intellectual content, see S. Zeller, "Mapping the Canadian mind: reports of the Geological Survey of Canada, 1842-1863," *Canadian Literature* 131 (1991): 157-167. Another study of explorer authorship is I. MacLaren, "From exploration to publication: the evolution of a 19th-century Arctic narrative," *Arctic* 47 (1994): 43-53.

[15] A helpful overview of all GSC publications to 1865 is given in the appendix to: Geological Survey of Canada, *Atlas of maps and sections* (Montreal, 1865) published as a companion to the *Geology of Canada.*

[16] The young American scientist Thomas Sterry Hunt (1826-1892) had been hired at the end of 1846 to replace E. S. De Rottermund. The most academically accomplished member of the early GSC, he had a long and distinguished career as a pioneering geochemist, including early contributions to the field of petroleum geology. See DCB; R. Boyle, "Geochemistry in the Geological Survey of Canada: 1842-1952," *Earth Sciences History* 12 (1993): 129-141; W. Brock, "Chemical geology or geological chemistry?," in L. Jordanova and R. Porter, eds., *Images of the earth: essays in the history of the environmental sciences* (Chalfont St Giles, U.K.: British Society for the History of Science, 1979), 147-170; on Hunt's publications, see J. Newell, "American geologists

appearance of new Reports of Progress often garnered some kind of notice in the press, ranging from polite interest to warm enthusiasm. This was true not only in English-language media such as the Toronto *Globe* and the Montréal *Gazette*, but also in French-Canadian papers such as the liberal *Le moniteur Canadien.* A long front-page feature article, appearing therein on the publication of the 1852-53 Report of Progress, noted approvingly that "[l]e plan et l'itinéraire suivi, par M. Logan, dans cette immense entreprise, nous paraissent réunir la facilité, la rapidité, et l'économie," and even if it did somewhat reproach Logan's style for exhibiting "une aridité trop *officielle*," it happily summarized the results of his explorations in Lower Canada, and thanked him sincerely for the "plaisir que nous a causé la lecture de son dernier ouvrage."[17] Logan himself also helped to spread the word about the Survey's endeavours, preparing for example an account of its history for publication in Hugh Scobie's popular almanac.[18]

Now that the Geological Survey of Canada's work was becoming more substantial and better known, a new problem dawned: the Appendices of the *Journals of the Legislative Assembly of the Province of Canada* were simply not the place that anyone expected to find major scientific publications. The general public might have had a growing awareness of Logan's work, but little idea of where to find it in print. And, even if one knew where to look, it could be very difficult actually to obtain a copy of a desired report; conversely, those who did receive them were not necessarily the intended

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and their geology: the formation of the American geological community, 1780-1865, " Ph.D. thesis, University of Wisconsin-Madison, 1993, p. ix.

[17] "Geologie canadienne," *Le moniteur canadien* (Montréal), 29 March 1855, in Scrapbook, TPL. See also, for a U.S. example, "Geological Survey of Canada," *Scientific American* 5, no. 48 (17 August 1850), p. 378.

[18] C. Smith, "William Logan's 1850 history of the Geological Survey of Canada," *Geoscience Canada* 26 (1999): 111-120. Perhaps it is not a coincidence that Scobie was a leader in lithographic printing, one of Logan's special interests; see DCB.

audience, and did not read them. As early as 1846, Logan complained that his work was being overlooked by the Provincial authorities in their handling of the copper mining fever on the north shore of Lake Superior. "A hint had been given to the Government in my first year's report of the possible existence of this mineral region," he sniffed. "But who the devil ever reads a report."[19]

An even more embarrassing incident occurred in 1852 when Charles Lyell, the most eminent living geologist, wrote to Logan asking for a copy of his lengthy and important study of the Joggins section (which had of course been conducted and published nearly a decade before). Neither Lyell nor his Nova Scotian collaborator, John William Dawson (who in three years would become Principal of McGill College), could find any trace of the document in print.[20] In reply, Logan could only explain that it had been printed, in his first Report, and that he had sent copies at the time to the Geological Society of London, to the British Geological Survey, and even to Lyell himself.[21] The point had been made clear, though: even Dawson, a fellow British North American geologist, was unsure where to look for publications of the Geological Survey of Canada.

In the case of U.S. surveys, it had been acceptable for annual reports to be delivered to the state Legislature, because the project had a finite lifespan and the final report, published as a stand-alone monograph, would soon be forthcoming. In the Canadian case, though, it was quickly becoming clear that the geological survey would not be finished in the near future, and that a general volume would be many years in the

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[19] Logan to De la Beche, 10 December 1846, DBP.
[20] On Dawson, see S. Sheets-Pyenson, *John William Dawson: faith, hope, and science* (Montreal & Kingston: McGill-Queen's University Press, 1996).
[21] Lyell to Logan, 16 December 1852, LP/MUA; Logan to Lyell, 10 January 1853, Edinburgh University Library, Gen. 113/3500-01.

making. Logan's 1845 Act had funded his project for five years, and in 1850 this was extended for another five.[22] By this point, it had become necessary for the government to pass additional measures in order to ensure that adequate supplies (some five hundred additional copies) of the Reports were printed, and the quality of the French-language translation improved.[23] As 1855 loomed, however, with neither an end to Logan's survey nor a formalized publication programme in sight, the government intervened by convening a Select Committee, a primary mandate of which was "to report upon the best means of making public the valuable information already obtained by the Geological Survey."[24]

After interviewing witnesses including Logan himself, the printer John Lovell, and several well-established North American geologists, the Select Committee's verdict came back:

> It is mortifying to your committee to have to report, that results of so much value are almost inaccessible to the public, and that a great proportion of the inhabitants of Canada, if not ignorant of the existence of

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[22] The Acts are 8 Vic. c.16 (1845), and 13-14 Vic. c.12 (1850).

[23] "Geological Survey," [Proceedings of Legislative Assembly,] Toronto *Globe*, 4 July 1850. The printing order was moved by Crown Lands commissioner James Hervey Price, while the linguistic request was elaborated by Pierre-Joseph-Olivier Chauveau, who explained that the regular translators' mistaken renderings of technical geological terms "was hurtful to our national reputation, as well as very annoying to Mr. Logan." On Price, a long-serving Reformer, and on Chauveau, the noted liberal politician, writer, and promoter of the French language, see DCB; their support for Logan's survey belies the idea that his project was essentially a Tory cause. The third speaker in favour of the this motion, as noted in the *Globe* report, was Logan's friend and staunch Tory, William Benjamin Robinson (see also chapter 6 below).

[24] J. Langton, "Report of Select Committee," Appendix L, JLA 1854-5. In addition to the nine-page report itself, this document reprints the complete responses of twelve witnesses to a total of over 170 questions, making it an invaluable resource for attitudes to Logan's survey. For further discussion, see Zeller, *Inventing Canada*, pp. 84-89; and Harrington, *Life of Logan*, chapter 13.

> the survey, are at least unacquainted with what it has achieved. The annual reports are presented to Parliament, and buried in the Journals of the House, except a few hundred copies, which are distributed by Members amongst their friends, so that the reports of two consecutive years rarely fall into the same hands.

Virtually all of the witnesses were in agreement that Logan needed more money, not only for the surveying work itself but also to help put his work before the public properly, through maps, a better museum, and, most importantly, through the republication of the survey's reports in a revised volume. John Lovell, a close friend of Logan's, and printer to the Assembly, testified that he currently printed an extra three hundred copies of each report (at his and Logan's own expense) for private distribution.[25] But he agreed with the other witnesses in estimating that, for a new general volume on Canadian geology, which would collect and distill the data previously published in the annual reports, at least ten thousand copies should be printed.

Despite its outward appearance, and despite some dissenting testimony from Count De Rottermund, who continued to lobby for an independent scientific position of his own, the Select Committee was not really intended as a hard-hitting investigation of Logan's efficiency, or of the value of his work: more accurately described, it was an opportunity for him to demonstrate to the provincial government the wide and deep

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[25] For the relationship between Logan and Lovell, and Logan's long hours recopying his reports by hand, see R. Bell, *Sir William E. Logan and the Geological Survey of Canada* (Ottawa, [1910]), pp. 4, 18. From 1852, Lovell was using steam-driven presses, a new technology in the Victorian era that permitted the publication of much larger numbers of copies of works at a much lower unit cost. These technical developments are discussed in more detail by Bryan Dewalt, "Printing technology," in Y. Lamonde et al., eds., *The history of the book in Canada: Volume 2, 1840-1918* (Toronto: University of Toronto Press, 2005), chapter 3, "Trades, labour, and design," pp. 89-101.

support for his project, and the demand for his published results. More than anything, it was a reaction to the communications crisis faced by the GSC, to the scarcity and poor distribution of their works. The Select Committee responded to this challenge by devoting its first three recommendations to laying out an ambitious publishing program for the survey, advocating: "the republication of not less than 20,000 copies of the revised reports, with a coloured map … the publication of the same number of the annual reports at future years [and] the periodical publication of 3,000 copies of plates and description of fossils." A proper dissemination of the reports was no less important: "four copies [were to go] to each Member of the Legislature, [as well as] copies to the Governments of all British Colonies, and the East India Company, for distribution by them to public libraries and scientific institutions, and one copy to every University, College, Literary and scientific Society, Mechanics' Institute, Library Association, Grammar, Normal and Model School, Municipal and Common School Library in this Province … and to the principal learned Societies in the United States and Europe." This scheme reflects Logan's grasp of colonial information networks, and his skill in harnessing the ability of local bodies to transmit scientific knowledge efficiently, and in response to local conditions.[26]

In providing the funds and mandate for this expanded publishing program, the Select Committee mapped out many of the GSC's activities for the next decade, including specialized paleontological monographs, depicting new species of Canadian fossils, and Logan's groundbreaking geological maps of northeastern North America. Both of these projects required some degree of international assistance, as they drew on

[26] Publication exchange was a common method by which local scientific societies built up their libraries.

expertise and technology not yet available in Canada.[27] It was the 1863 compilation volume, entitled *Geology of Canada*, that made the largest impact, reached by far the broadest audience, and left the longest-lasting impression.[28] This work emerged partly despite, and partly because of, repeated financial crises – Logan had to purchase $3,000 worth of type for the volume himself. Interestingly, it appeared as one more in the series of annual reports, bearing the corporate subtitle "Geological Survey of Canada: Report of Progress from its Commencement to 1863." Published by Dawson Brothers, however, rather than Lovell, it ran 983 pages, and was illustrated by 498 woodcuts.[29] Logan personally drew up a list of English, Scottish, and Irish scientists and institutions that he wished to see receive a copy.[30] The *Geology of Canada* was not only Logan's magnum opus, but one of the pinnacles of Canadian scientific publishing in the nineteenth century.[31]

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[27] See P. von Bitter, "Sir William Logan's geological maps of Canada," *Map Collector* 68 (1994): 12-18; and, R. Cleevely, "John W. Salter, Sir William Logan, and Elkanah Billings: a brief British involvement in the first Decade of 'Canadian Organic Remains' (1859)," *Earth Sciences History* 12 (1993): 142-159.

[28] See, for example, the summary articles "Geological Survey of Canada," Toronto *Globe*, 26 December 1863, p. 2, and 3 February 1864, p. 2. Zaslow, *Reading the rocks*, chap. 4, details the additional geological fieldwork undertaken in preparation for this volume. See also W. Eagan, "Reading the 'Geology of Canada': geological discourse as narrative," *Scientia Canadensis* 16 (1992): 154-164.

[29] It can be supposed that Logan's reasons for switching from Lovell to Dawson Brothers more likely logistical than technical. It should also be noted that although Logan served as general editor and was the chief contributor, substantial parts of the work were written by other officers of the Survey, most notably T. S. Hunt.

[30] Colonial correspondence shows, however, that Canadian administrators were not as adept at effecting imperial distribution: in sending a large number of unaddressed copies of the *Geology of Canada* to Britain, they managed to incur the wrath of the Colonial Office. See Monck to Newcastle, Despatch 3, 20 January 1864, CO 42/640; Monck to Newcastle, Despatch 58, 18 April 1864, CO 42/641, PRO. See also W. Logan to Provincial Secretary, 1 January 1864, Central registry files, vol. 292, RG 45, LAC.

[31] For context, see B. H. MacDonald, "Science and technology," in Y. Lamonde et al., eds., *The history of the book in Canada: Volume 2, 1840-1918* (Toronto: University of

If it was the peak, though, it did not mark the end of the Geological Survey of Canada and its publications. Contrary to the expectations of the provincial government in 1842, and to the experiences of the American state surveys, the GSC eventually became a permanent institution. This unlikely achievement has often been seen as Logan's surpassing accomplishment in his role as Survey director, and has been attributed to his ability to convince both ordinary Canadians and politicians of the value of the Survey's work. But how exactly was he able to do this? The main challenge that Logan faced in educating Canadians about their geology was in making the rocks of their country "visible" to them. In addition to his maps, and his acclaimed international exhibits, it seems to me that print was a crucial tool in Logan's campaign to uncover the scientific and economic secrets that lay buried in the Canadian wilderness.

The system of annual reports, which he initially dreaded as a hindrance to his work, ironically turned out to be one of his most powerful instruments in this task.[32] By describing separately the geological, topographical, and economic features of the landscape, Logan was able to display to Canadians the past, present, and future of their land. Though they were intended to fulfill only a temporary, bureaucratic role, Logan insisted on putting so much effort into these Reports of Progress that they became important and desirable in their own right. This issue was resolved by the Select Committee's call for a separate volume of wide distribution. Thus, it was not only

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Toronto Press, 2005), ch. 13, "Print for work and leisure," pp. 423-428. Also, in November 2005, the *Literary Review of Canada* named the 1863 report as one of the six most important works of any kind published in nineteenth-century Canada; it was the only strictly scientific work to appear on the list of the one hundred most significant books in Canadian history.

[32] Given that "reading the rocks" is a common metaphor for geological fieldwork, I suggest that "writing the rocks" be seen as an equally important element of successful surveying practice.

Logan's use of print, in the development of a new genre of practical geological writing, that contributed to his success: it was also his use of print culture, in taking advantage of schools, libraries, and scientific institutions to disseminate the *Geology of Canada* to its intended audience, both within the colony and abroad.[33]

After all, the reception of Logan's work in the motherland was also important to his aims. As one British review of the *Geology of Canada* noted, the physical form of a geological publication was a key component in establishing its validity as a national emblem: "The style in which the work has been got up, the precision of the drawing, and the accuracy of the woodcuts, may almost challenge comparison with the execution of similar productions on this side of the Atlantic. There has been a steady persistence in the conduct of this remarkable Survey .... No other Colonial Survey has ever yet assumed the same truly national character; and the day may come – if ever the 'Imperial Colony' shall claim and obtain independence – when the scientific public of a great land, shall regard the name of Logan ... with the same affectionate interest with which English geologists now regard the names of our great geological map-makers."[34] By enabling Logan to spread his message effectively, to reveal the Survey's findings in a powerful and persuasive form, and to establish his international authority and credibility, print was central to everything that Logan achieved as a geologist in Canada.

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[33] On science and Victorian print culture, see J. Secord, *Victorian sensation* (Chicago: University of Chicago Press, 2000).

[34] Quoted in Harrington, 351-2, and repeated in Zaslow, 81. (Uncited quotation from the *Saturday Review*.) The point is two-fold: that geological knowledge underlay national identity, and that Logan's efforts sufficiently fulfilled this role in Canada. For another review in a similar vein, see "Geological Survey of Canada," *Athenaeum* no. 1904 (23 April 1864): 577-578.

5.2 A Knight to Remember

As much as print provided the essential basis for William Logan's transformation of field experience into scientific fact, it would take more singular forms of communication to raise the Geological Survey's work to its highest profile. Mid-nineteenth century international industrial exhibitions attracted enormous attention; London's Great Exhibition of 1851, often seen as inaugurating the genre, remains the best known today and not without reason. Six million people viewed the products of seventeen thousand exhibitors under the "Crystal Palace," a revolutionary glass structure covering the nineteen-acre site. For those who participated, there was no better opportunity to reach the broadest possible audience and to leave the strongest possible impression. This was true no less for the governments of far-flung colonies than for Europe's most advanced manufacturers. So it should come as no surprise that William Logan's display of Canadian economic minerals, and its sequel at the Paris exposition of 1855, represented the zenith of his international reputation. Correspondingly, these exhibits are today the best-remembered fruits of his three decades as founding director of the Geological Survey of Canada. Logan received a knighthood in 1856, in recognition of his services at the exhibition of 1851 and 1855, thus cementing his reputation as Canada's pre-eminent scientific figure of the nineteenth century.

Why, then, look yet again at Logan's exhibits of economic minerals, if they are so well-known and their importance so widely admitted? It is just because they were so highly visible, and, even more importantly, because they were designed with this condition in mind, that they are so revealing, both of how the colonial government's Geological Survey wanted to be seen, and of how it was understood. In this section, I examine a series of connected themes in taking a closer look at this topic. Beginning with Logan's early geological displays, and their basis in his field work, I look at the exhibition staged in Montreal in 1850 as a prelude to London. Next, I examine his role at the Great Exhibition itself, and evaluate the contemporary response to it. Finally, I conclude with a reassessment of the function of exhibitions as developed by the Geological Survey of Canada, and offer some additional ideas as to why Logan was regarded so highly in the mid-nineteenth century.

When William Logan began his geological explorations of the colonial Province of Canada in 1843, he knew that putting together collections of rocks, fossils, and minerals was a top priority. Crate after crate of specimens were extracted from the wilderness and shipped back to his headquarters in Montreal for description, cataloging, and, in selected cases, eventual display.[35] Logan knew from his experience as a geologist in Britain, particularly as honorary geological curator for the Swansea Literary and Philosophical Society (Royal Institution of South Wales), that physical materials were crucial for spreading geological knowledge to the public.

As a specimen, any given lump of rock, whether fossil or mineral, had two functions in an exhibit. First, it demonstrated the authority of the person who collected and displayed it, by establishing a direct link between the natural world – the structure, composition, and history of the Earth – and the social and cultural environment in which the object was viewed. Rocks in a museum, or any other exhibit, stood for the geologist's expertise in locating, identifying, classifying and labeling nature itself. Second, these specimens were also the tool by which such knowledge was propagated.

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[35] W. Logan, "Gaspé 1843," Field notebook 1964, vol. 177, RG 45, LAC.

Only by looking at physical samples could members of the general public truly grasp the differences between one species of trilobite and another, or between two different kinds of iron ore. (In theory, the truly keen might even learn how to make such distinctions themselves, and take this knowledge back into the field, applying it there and thus complete the circle.) Hence, Logan planned from the start for public exhibits as a fundamental component of his geological survey in Canada.

In its early years, the Survey's museum migrated from the upper floors of a warehouse owned by William Logan's brother James, to a building owned by the Natural History Society of Montreal. The Provincial Exhibition of 1850 offered a chance to put the Survey's collections before the public at a time when interest and publicity were at their height.[36] This exhibition, held in Montreal in late October of that year, had been organized in order to select the materials to be sent to London for the Great Exhibition, so that they would accurately represent the best of Canada.[37] Naturally, Logan took an active part in this endeavour. He was one of the few people regularly employed by the colonial government to make an inventory of its resources. However, the idea behind such exhibitions, which were really meant to emphasize manufactured goods, was that private individuals should contribute the majority of the items for display. In the case of geological materials, Canadians needed some help in knowing where to look and what to look for, and this is where the Geological Survey came in.

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[36] On Victorian public audiences for science, see the classic work by R. Cooter & S. Pumfrey, "Separate spheres and public places: reflections on the history of science popularization and science in popular culture," *History of Science* 32 (1994): 237-267; as well as the very pertinent analysis by S. Alberti, "Conversaziones and the experience of science in Victorian England," *Journal of Victorian Culture* 8 (2003): 208-230.
[37] "Report of the Select Committee on the Industrial Exhibition," Appendix L, JLA 1850. On both domestic and international exhibitions in nineteenth-century Canada, see E. Heaman, *The inglorious arts of peace* (Toronto: University of Toronto Press, 1999).

In a grand announcement "To the Public of Canada," the organizers of the Montreal Exhibition explained the various categories of raw geological resources in which entries were sought. In a footnote, they admitted that "the Committee will shortly publish a list of the localities where the above Minerals may be found, furnished by W. E. Logan… Provincial Geologist."[38] This separation of roles between the public and private sectors was not entirely realistic, of course. To begin with, a large proportion of the specimens contributed came from the Geological Survey's own collections anyway. Many more came from individuals with whom Logan had already developed a working relationship. And of that minority who submitted minerals entirely on their own initiative, the meaning and validity of their contributions could be established only by Logan and his Survey colleagues. As a result of Logan's successful 1840s campaign to prove that coal did not exist in Canada, there was no longer any room for alternative interpretations of the geochemical composition of a sample, or its economic potential. So while the exhibition harnessed private enterprise to gather materials, Logan himself controlled the arrangement of the mineral display, and would supply its proper interpretation.

What was the reaction to the Montreal Exhibition? Fifteen thousand people, more than a quarter of the city's population, paid admission in the first two days alone, to see what their province had to offer. According to the Montreal *Gazette*, "On entering the building and ascending the stairs, the first feeling is that of astonishment at the immense labour, which the members of the Committee must have been at in classifying, arranging, studying, and rearranging, the vast number of articles, of so many different

[38] "Report … on the Industrial Exhibition."

sorts, sizes, hues and properties.... Nor less do we admire, upon closer inspection, the great taste with which they have all been combined into one harmonious whole."[39] Logan's geological exhibit shared a table with two others, both of which the *Gazette* could easily assess: "a cabinet of specimens of pure gold," weighing 2 lbs 11 oz and worth $11,000; and a model of Quebec City, made of out of straw, "a very true picture." It was harder to judge Logan's mineral collection, however: although "splendid," the specimens "would require a book to enumerate them, and years to study them; we can, therefore, but refer the visitor to the part of the room in which they are to be found."

According to Logan's three-page catalogue, the mineral collection was arranged under the following categories: metals and their ores; chemical materials; stone paints; materials applicable to the arts; materials applicable to jewellery, and ornamental purposes; materials for glassmaking; refractory materials; manures [fertilizers]; grinding and polishing materials; materials for paving and tiling; building materials; materials for bricks and pottery; combustible materials; and sundry other materials.[40] Hundreds of localities are given, for at least sixty different types of minerals. At first glance, a display based on such principles appears every bit as miscellaneous as the rest of the colonial exhibition. Nevertheless, the *Gazette* ventured to say that it formed "almost a history of the geology of the Province." Presumably referring more to the sheer variety of specimens than to an explicit interpretative structure offered, this reaction is nonetheless striking, because the exhibit was much more about industrial development than about natural history in a more narrowly scientific science. Accordingly, though the Survey

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[39] Montreal *Gazette*, 18 October 1850.
[40] GSC, "Catalogue of some of the economic minerals and deposits of Canada, with their localities," Appendix V, JLA 1850.

had a good collection of Canadian fossils, these were consciously *not* on display in this exhibition, because they were seemingly devoid of economic value and only likely to attract criticism from those who thought the Survey a waste of money.[41]

How, then, was Logan's exhibit designed to argue that the Geological Survey was indeed economically valuable? At this point, he had only located and described resources in terms of their theoretical potential: any assessment of the commercial viability of these deposits, much less actually raising the capital to work them, remained firmly in the future, and for others to do. In contrast to the message implied by the samples of "pure gold" that sat next to his collection on the exhibit table, Logan advocated taking a slow, steady, and reliable route to economic development. His Survey had to negotiate a careful course between abstruse science and greedy speculation; in fact, he was deeply opposed to the gold-promoters, who gave people false hope and induced them to waste their money on futile schemes. Just as he had debunked the existence of coal, Logan engaged in several public disputes in an effort to prove that the gold deposits in question were too sparse to offer any return on investment.

Logan's arrangement of his mineral collection offered an alternative path to industrial growth. Instead of organizing the materials according to chemical composition, geographical location, or geological age, he placed them into categories according to the useful products that they could one day become. Slate, granite, and sandstone, for example, do not form a natural scientific class of objects, but all have important uses in the construction of buildings. In grouping materials according to their

[41] For the context of this common tension in Victorian public attitudes to geology, see J. Morrell, "Economic and ornamental geology: the Geological and Polytechnic Society of the West Riding of Yorkshire, 1837-53," in I. Inkster & J. Morrell, eds., *Metropolis and province* (Philadelphia: University of Pennsylvania Press, 1983), 231-256.

industrial application, he was following the advice of the government's select committee, which pointed out that the 1851 Exhibition had issued the following instruction to prospective contributors: "It is desirable that the Raw Materials should be shewn in connection with the produce [i.e., finished products] of the Mineral Kingdom, so as to form a history and explanation of the processes employed to fit them for the useful and ornamental purposes of life."[42] While exhibitors from industrially-developed nations could interpret this as a request to focus on the technologies of extraction, refining, and manufacturing, Logan was under no such constraints with his Canadian rocks, because at present they remained, almost without exception, firmly rooted in the ground. He had no finished products to display, and so he arranged his minerals only according to what they might become. Rather than depicting the mineralogical and metallurgical "history" of industrial processing, he showed the first stage in the future history of Canadian economic development, projecting a day when all inhabitants of the colony would freely enjoy the fruits of Canada's geological resources: lithographic printing; jewellery ornamented with semi-precious stones; goods painted with exotic pigments; fields enriched with mineral fertilizers; roofs covered in sturdy, fireproof slate; facades dressed in marble; and streets paved – if not with gold – then at least with bricks of stout construction.[43]

[42] "Report… on the Industrial Exhibition."
[43] Of all these, the use of lithographic stone to permit the printing of colours and images was the application that captured Logan's heart first. In 1844, he wrote to De la Beche, "Can you tell me what the consumption of Lithographic stone is in Britain & in France or how much of it is quarried from the only locality it is obtained of good quality namely at Kelheim on the Danube? …. I should very much like to know … in order to shew the Canadians that they have something of value in their Country" (Logan to De la Beche, 20 April 1844, DBP). He also mentioned the topic at the outset of his 1843 Report of Progress (dated 28 April 1844; RP 1843). Interestingly, lithographic stone was of

This, then, is the exhibit that William Logan took to London in 1851, and for which he received great acclaim. Although it made use of the same collection of minerals, much effort was required to effect the exhibit: the packages were delayed en route to Britain simply because of their tremendous size and weight.[44] Once the materials arrived, Logan had to work fourteen-hour days to put the Canadian display in order, profiting from a "judicious" allocation of space made by the general commissioner of the Canadian section, Henry Houghton.[45] While the 1851 Exhibition aimed to showcase advanced industrial products and designs, there was also a category (I) for the display of raw materials, in which the Canadian geological collections found a home. (In fact, all of the colonial exhibitions were grouped together by colony, rather than being divided among the different technological classes.) And, as much as the Great Exhibition has been seen as embodying a political-economic agenda that implied the recapitulation of industrialization around the world, it should be remembered that the system of classification, heavily influenced by the advice of Lyon Playfair (see below), was mainly

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particular significance to geologists at this time because of its use both in printing geological illustrations and complex many-coloured maps. These topics are treated in detail in M. Rudwick, *Scenes from deep time* (Chicago: University of Chicago Press, 1992) and K. Cook, "From false starts to firm beginnings: early colour printing of geological maps," *Imago Mundi* 47 (1995): 155-72.

[44] W. Logan, "Industrial Exhibition, London, England," Field notebook 1995, vol. 159, RG 45, LAC.

[45] For Logan's account of the collection, see RP 1851, pp. 53-62; on Houghton, see p. 62. An image of the Canadian display can be found in J. Nash, *Dickinson's comprehensive pictures of the Great Exhibition of 1851* (London: Dickinson Brothers, 1854), vol. 2, plate XI, which shows manufactured articles such as a carriage, sleigh, canoe, and fire engine clearly. Details of the Canadian mineral cases are not visible, but Plate XXIII gives a good impression of the British mineral display, laid out on tables and in horizontal cases, with the largest specimen upright. Also interesting are the depictions of exhibition visitors' postures and activities within the mineral display.

practical, and that the simplicity of the displays of foreign natural resources in category I appealed to many visitors.[46]

There is no doubt that Logan's finished product resonated with viewers. It received a very full description in the exhibition guide produced by Robert Hunt, who was keeper of the British geological survey's museum.[47] The reception in the less-specialized press, while also warm, was perhaps less perceptive, such as the notice in the *Illustrated Exhibitor*, which emphasized first and foremost the samples of gold which held the potential to make "the region extending widely round Quebec a second California," although it did succeed in grasping the underlying message that "Canada, in addition to her fertile soil, contains in the bowels of the earth all the resources necessary to render its inhabitants powerful and prosperous."[48] Most significantly, however, the secretary of the Class jury, A. Dufrenoy wrote: "Of all the British colonies, Canada is that whose exhibition is the most interesting and the most complete; and one may even say that it is superior, so far as the mineral kingdom is concerned, to all countries that have forwarded their products to the exhibition."[49] The jury only regretted that it could not award Logan a formal medal because he had also agreed to serve as a juror, assessing the mineralogical exhibits of other nations, and thus he could only receive an honourable

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[46] In general, see J. Auerbach, *The Great Exhibition of 1851: a nation on display* (New Haven, CT: Yale University Press, 1999), but see also A. Briggs, *Victorian things* (Stroud, Gloucestershire: Sutton Publishing, 2003), especially pp. 38-54.
[47] R. Hunt, *Hunt's hand-book to the official catalogues: an explanatory guide to the natural productions and manufactures of the Great Exhibition of the industry of all nations* (London: Spicer Brothers, 1851), vol. 2, pp. 710-718.
[48] "Canadian contributions to the world's fair," *Illustrated Exhibitor* no. 16 (20 Sept. 1851), pp. 277-279.
[49] Great Exhibition of the Works of Industry of All Nations, *Official descriptive and illustrated catalogue* (London, 1851), "Reports by the Juries," Class I.

mention.[50] What was it that struck Dufrenoy and others so strongly about Logan's display?

Modern commentators have focused on the message presented by the rocks and minerals themselves, and this is undoubtedly accurate.[51] Logan had retained the same system of classification that he used in Montreal, arranging materials under such headings as metalliferous minerals, and metals obtained from them; rocks and minerals in use for improving soils; materials used in construction, and rocks serving for architectural decoration; minerals employed in jewellery, and in the manufacture of glass of different kinds; and (a possible metaphor for Canada itself?) "minerals which require complicated operations to render them fit for use." Again, this arrangement was neither arbitrary, nor unscientific, nor miscellaneous. Dufrenoy praised Logan's system as "entirely technical," claiming that "the collection has been made in a systematic manner, and it results that the study of it furnishes the means of appreciating at once the geological structure and the mineral resources of Canada." For Dufrenoy, who was the French Inspector-General of Mines, the geological structure of a country was apparently not a matter of surveying and stratigraphy: it was more properly the sum of its mineral contents, an indication of the future industrial production it would support. In this sense,

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[50] Logan mentioned this recognition in his account of the Exhibition (see RP 1851, p. 57), but ultimately decided against publishing the feelings he recorded in his draft version:

> The character of the notice is such that it renders the award of any other distinction of but little importance & it is chiefly gratifying to me as tending to shew that the mineral resources of the Colony are such as to merit the investigation of them which an enlightened view of the general interest has induced those administering the government to institute & that the examination, I hope I may be permitted to say has been prosecuted with due diligence by those to whom it has been entrusted.

This passage is marked "to be left out"; W. Logan, "Report of Progress 1851-2," 14 May 1852, box 2, Logan manuscripts, ESIC; see ms. p. 44.

[51] Heaman, *Inglorious arts of peace*, chap. 6.

Logan's exhibit was a powerful argument for the economic importance of Canada's natural mineralogical resources.

However, there was a second element to the jury's praise. Dufrenoy reminded his readers that Logan was not merely the overseer of the exhibit, he was the "Geological Surveyor of Canada," and, as such, the "value" of his collection "arises from the fact that he has selected on the spot most of the specimens that have been sent to the Exhibition, and has arranged them since their arrival in London." In other words, the rich meaning of the Canadian minerals was grounded deeply in Logan's own field experience, in his expertise in identifying rocks and their economic potential, and in his ability to arrange them in a way that accurately represented Canada. Because so many of the specimens had been gathered by the Geological Survey itself, the exhibit reflected an understanding of the colony's intricacies that could only be obtained through years of arduous exploration. This irreplaceable insight was the true highlight of the display. Recall that Logan himself was of Canadian origin, and that the purpose of the Great Exhibition was to show the best products of each nation to the world. In this sense, it can also be said that the most remarkable feature of the Canadian exhibit was not the rocks and minerals themselves, but the person (and the Survey) who discovered, mapped, identified, and explained them.

As much interest as the Canadian minerals attracted in London, even more attention was paid to the geological surveyor himself. Logan had not been back in Britain for eight years, ever since he began year-round work in Canada in 1843. Now, his friends in gentlemanly scientific circles seized the opportunity to make up for lost time, securing in short order his election as a Fellow of the Royal Society, the first time a

Canadian scientist had received that distinction. No fewer than eleven prominent geologists and naturalists signed Logan's election certificate, claiming personal knowledge of him, including H. T. de la Beche, Edward Forbes, Andrew Ramsay, Charles Lyell, and Charles Darwin.[52]

A similar display of economic minerals was assembled for the Paris international exposition in 1855, and again it garnered considerable publicity and praise.[53] On this occasion, Logan and his chemist, T. S. Hunt, also produced an essay outlining the geology of Canada, and a small reproduction of his manuscript display map was printed along with it. At a scale of 150 miles to the inch, it showed geological features only in broad terms, and contains many blank areas in neighbouring territories. Nevertheless, this map was extremely well-received in Paris, and it brought to the zenith of his fame. Logan was made a Chevalier of the French Legion of Honour,[54] and in January 1856 was knighted by Queen Victoria, a feat accomplished with the help of Lyon Playfair, a chemist with the Geological Survey of Great Britain who had close connections to the British government.[55] Logan also received (though he could not stay in London to accept it personally) the highest award of the Geological Society of London, the Wollaston Medal. As the President of the Geological Society said, "I consider this map to be one of

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[52] Royal Society of London, Sackler Archive, A04416. Online at http://www.royalsociety.org/library/

[53] See Heaman, *Inglorious arts of peace*, pp. 154-167.

[54] Ordre Impérial de la Légion d'Honneur, "Nomination de Chevalier," 13 November 1855, folder 2, box 4, LP/MUA. This document cites Logan's "travail remarquable de la carte géologique de cette contrée" and his "périls courus dans l'intérêt de la science." He was subsequently promoted to the rank of Officer on the occasion of the second Paris exposition in 1867.

[55] Logan to Playfair, 20 November 1855, item 458, Lyon Playfair Papers, ICST. This letter also describes the administrative difficulties that Logan had with a medal for Hunt, with the *Grande medaille d'honneur* for the mineral display, and with the loss of his notebook detailing all of his exhibition-related expenses.

the special grounds which entitle Sir William Logan to the medal ... I am sure that every one who saw it in the Paris Exposition, or subsequently in this country, must have been struck with its execution, and the clear idea it conveyed of the geological structure of the country."[56]

By the mid-1850s, then, it was quite clear to Canadians that they were possessed not only of outstanding geology, but of a rather remarkable geological surveyor. It was Logan himself who now became an item of pride in the colony, symbolizing that its best products were equal to the finest of Europe. As Logan himself said at a ceremony to honor his accomplishments in Toronto, "Having carried our work to France and to England, and having submitted it to the test of a proper examination, our metal [sic] has been found to be good and true."[57] A regional Ontario newspaper expressed a similar sentiment in more direct language, under the headline "Canada against the World!": "Our country is rich in everything that constitutes geographical greatness, but were we without a Logan our greatness would never have been known to the outside world.... his ability is almost universal, his efforts indefatigable, and his whereabouts almost ubiquitary, always at hand when anything is wanted to forward the interests of Canada."[58]

It is no wonder, then, that Logan's mineral displays at international exhibitions play such a large role in accounts of his life. They were the occasions upon which Canadians themselves, as well as the rest of the world, saw most clearly how potent the results of the Geological Survey were. We have seen that the highly-praised collection

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[56] W. Hamilton, "Award of the Wollaston Medal," *Quarterly Journal of the Geological Society of London* 12 (1856): xxi-xxvi.
[57] *Globe*, n.d. [April 1856]. In W. Logan, "Scrapbook," TPL.
[58] *Canadian Statesman*, Bowmanville, 6 Sept [1855]. In W. Logan, "Scrapbook," TPL.

exhibited at the Crystal Palace in 1851 was not created solely for that event: it had its roots in Montreal's provincial exhibition of the preceding year, and thus had a meaning for a Canadian audience before it acquired one abroad. Equally, however, the fact that it did attract international attention helped Canadians appreciate what the Survey could do for their colony. To the question, "The geological survey – of what use is it?," an Ottawa newspaper could easily provide an answer in 1859 according to the script Logan had laid out at the beginning of the decade. "Once it is ascertained what is our supply of the various metallic ores… or of rocks fit for lime, cements, building, roofing, flagging, polishing, or sharpening tools… or for ornamental work or jewelry… or for manures, such as marls, coprolites, carbonates, or phosphate of lime; or what earths are fit for tiles, bricks, or pottery… when all these, and a great deal more shall have been ascertained… then we shall be in a position to form an opinion of the value of the Province, what branches of industry will pay and should be encouraged."[59]

Canadians were not the only ones to imagine a prosperous, comfortable future for their colony, founded upon accurate scientific and geographical knowledge.[60] Logan's exhibits also served the larger cause of empire, by holding out the promise of colonial self-sufficiency, not just in basic economic terms, but also in intellectual control. Like printed reports and maps, arrangements of physical specimens offered a way to understand what the territory was made of: the Geological Survey's field work had distilled and abstracted the raw chaos of Canada's unknown wilderness, into manageable pieces of data, into a form that could be understood equally well in London as in Quebec.

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[59] Ottawa *Citizen*, 29 March 1859. In W. Logan, "Scrapbook," TPL. This refers specifically to the London and Paris exhibitions as "taking stock".
[60] London *Times*, 7 September 1855. In W. Logan, "Scrapbook," TPL.

Like other information-gathering projects in mid-nineteenth-century Canada, the work of the Geological Survey was also an important part of the process of state formation. Logan's work thus meant different things to different audiences, whether they were distinguished European scientists, the expanding colonial government, or enthusiastic Canadians in general. What these groups had in common was the excitement they felt when they experienced a display of the economic minerals of Canada, a result of William Logan's rare ability to take the results of painstaking field work and give it a visual, spatial, organized form.

5.3 'Few read but everyone can see'

On the ninth of December, 1854, the Province of Canada's Legislative Assembly voted £588 17 s. 1 d. for "alterations to the Geological Museum at Montreal"; six months later, they added another £500 to this sum.[61] While these grants were modest, even by the standards of the young colonial government, they indicated a real belief that such a thing as a geological museum was worth having.[62] When the Geological Survey of Canada had begun, a little more than a decade earlier, in 1842, the appropriation for the entire project had been only £1500. This was soon extended to £2000 annually, but by 1854 there was growing concern that the work was seriously underfunded, and in particular

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[61] JLA 1854-5, p. 505; p. 1203.

[62] For invaluable reviews of recent approaches to the history of natural history museums, see S. Alberti, "Objects and the museum," *Isis* 96 (2005): 559-571; and S. Forgan, "Knowledge, conflict, and the power of place." *Isis* 96 (2005): 572-585. While the perspectives discussed therein, such as the nature of the collections, the architecture of the buildings, and the experience of visitors, inform the discussion that follows, the existing records of the Logan's first geological museum (abandoned when the GSC moved to Ottawa in 1882, and long since built-over) do not permit an analysis in nearly as much depth as is possible for certain British museums.

that the Survey's results, although good, were not being disseminated quickly or widely enough. Accordingly, the Select Committee of the Legislative Assembly had recommended a tripling of the Survey's funds, a renewed commitment to the publication of maps and reports, and a complete overhaul of the geological museum.[63] Previously, the "Provincial collection," as it had originally been mandated by the Act establishing the Survey, had been little more than unstaffed storage space, with the annual influx of new specimens far outstripping the Survey's ability to describe, classify, arrange, and display them.[64] Now, beginning in 1856, the Survey was to have a real public museum, established "upon an efficient footing," open regular hours, and overseen by a full-time paleontologist and curator.[65] The Geological Survey was the Canadian colonial government's most ambitious scientific project, and the museum would be its public face.

Public visibility was indeed crucial if the Survey was to benefit the public. The Select Committee had found it "mortifying ... to have to report, that results of so much value are almost inaccessible to the public."[66] The chairman of the committee admitted that a "very large portion" of the materials collected by the Survey was still packed away in boxes, unseen by visitors, due to the lack of time, space, and resources to prepare

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[63] J. Langton, "Report of the Select Committee appointed to report upon the best means of making public the valuable information already obtained by the Geological Survey, and completing it at an early stage upon an uniform system," Appendix L, JLA 1854-5. (Unpaginated; cited as SC below.)

[64] See Canada, 8 Vic. c. 16, *An Act to make provision for a Geological Survey of this Province* (1845). The first repository of the GSC's collection was the warehouse of the Montreal merchant James Logan, brother of Survey director William E. Logan. See Harrington, *Life of Logan*, p. 177. For the Survey's later quarters, see Zaslow, *Reading the rocks*, pp. 48-49.

[65] 19-20 Vict., c. 13, *Statutes of the Province of Canada*, 1856. For the Redpath Museum, a successor institution in Montreal, established in the early 1880s after the Survey's move to Ottawa, see S. Sheets-Pyenson, *Cathedrals of science* (Montreal & Kingston: McGill-Queen's University Press, 1988).

[66] SC, Final Report, 29 March 1855.

exhibits. While the Select Committee's main concern was for the publishing of useful reports and geological maps, the prominent scientists and enthusiastic amateurs who testified before it in the autumn of 1854 agreed that a museum was central part of an educational program, and should not be neglected.[67] As the Survey's director, William Logan confirmed that the funds granted to date had been sufficient only for the basic maintenance of the museum building, and had not provided for all the necessary fittings and displays.[68] Even worse, one of the most famous and influential scientists in the United States, the Harvard zoologist Louis Agassiz, wrote to the Select Committee: "I know from the reports of visitors competent to judge of such matters, that the value of the large collections brought together by the energy of Mr. Logan, is greatly impaired, and that the collections are rendered almost inaccessible to those who would derive great benefit from their examination, by being heaped together, as they are, without systematic arrangement." Instead, Agassiz urged, "A Geological Museum scientifically arranged would not only be a source of invaluable information; but also an ornament to your city, and ... would set an example worthy of being followed through the whole continent."[69] The extent to which Agassiz's deposition to the Select Committee was stage-managed, and the fact that Logan and his supporters were anxious to have its conclusions reflect their version of what a geological survey should be, is evident from a dinner that he and T. S. Hunt had with Agassiz in April 1855, during which Agassiz dismissed Logan's

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[67] SC, Minutes of Evidence: 11 Oct 1854, James Hall, Question 6; 12 Oct 1854, E. J. Chapman, Q. 48; n.d.., Andrew Bell, Q. 114; n.d., Rev. Prof. Horan, Q. 121, 127.
[68] SC, Minutes of Evidence, 14 October 1854, W. E. Logan, Q. 69.
[69] SC, Minutes of Evidence, 22 Nov 1854, L. Agassiz to J. Langton, letter. On Agassiz's place in American science, see R. V. Bruce, *The launching of modern American science 1846-1876* (New York, 1987).

concern about De Rottermund's efforts to reorient the Survey towards mere mineral searches.[70]

Logan, for his part, was well aware of what was to be gained from good museum displays. They imparted basic facts in a direct way that words alone could not. Referring to an example of an anonymous writer who was then spreading the damaging and discredited belief that coal existed in Canada, Logan announced: "If he should come to Montreal, I hope he will pay a visit to our museum; by showing him the geological model ... he would without one word of explanation thoroughly understand, that the bituminous shales in Collingwood are a great depth beneath the coal of Michigan."[71] In referring to another case, the recent opening of slate quarries to provide roofing material for fire-prone Montreal, Logan appealed to the power of exhibits to speak to the many: "An example is worth twenty reports. Few read but everyone can see, and this example [is] for the vicinity, and in regard to this one material, what I wish to make the economic department of the museum for the whole public and all our materials."[72] The power of sight to engender understanding, and of understanding to promote imitation, was particularly important to Logan's mission of Canadian industrial development. "It requires little tuition to comprehend the objects of industrial art," he wrote optimistically, "and imitative skill is more excited by the sight of such objects, than by written

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[70] Logan wrote: "Hunt and I dined with Agassiz yesterday. I told him of the fear we entertained that his letter to Mr Langton might be made a handle of for mineral explorations: but he seemed to think that if properly interpreted it could not do harm. I did not therefore ask him to write a second. In regard to De Rottermund he seemed to think that I ought to treat such a "damned ass" with contempt + silence. I shall give him a side wipe however somehow or other." Logan to James Hall, Boston, 11 April 1855 [en route to Paris]; Merill Collection, Box 3, Foreign Geologists 'L', Library of Congress, Washington, D.C.; thanks to Michele Aldrich for this citation.
[71] SC, Logan, Q. 86. Collingwood is on Georgian Bay, Lake Huron.
[72] SC, Logan, Q. 88.

descriptions." The mere act of viewing a collection of economic minerals would cause people to "recognize substances which they have in abundance at their own doors," and "prompt attempts to make them available." The museum would thus be "a school of mineral arts" and "a means of exciting native industry."[73]

This was Logan's ambitious philosophy of geological displays; the marked contrast between it and the actually existing state of affairs in 1854 explains why the two special grants, totalling over £1000, were made by the Legislative Assembly in the period immediately after the Select Committee met, and even before the Survey's new, more generous Act was passed. These grants, made less than six months apart, were together more than five times the amount recommended for the museum's regular annual maintenance.[74] With new funding in place, in 1856, director Logan was finally able to hire his new paleontologist and curator, Elkanah Billings, who along with Logan would be responsible for the design and implementation of the museum's exhibits. Billings was self-taught, like many geologists of the time, but he had amassed a substantial private collection of fossils, and had recently distinguished himself by founding one of Canada's first scientific journals.[75] Logan, by contrast, had begun his geological career more than

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[73] RP 1851, pp. 62-63.

[74] SC, Final Report, Estimated annual costs. University of Toronto geologist Edward Chapman, one of the witnesses before the committee, wrote to Logan just before the GSC's Act was renewed: "If any clique interests stand in the way, public opinion I imagine will be found a little too strong for their gratification." E. J. Chapman to Logan, 22 March 1856, LP/MUA. On Chapman, see DCB.

[75] See H. J. Morgan, *Sketches of celebrated Canadians* (Montreal, 1865), p. 693-4; also M. Copeland, "Elkanah Billings (1820-1876) and Joseph F. Whiteaves (1835-1909): the first two paleontologists of the Geological Survey of Canada," *Earth Sciences History* 12 (1993): 107-110. The journal was the *Canadian Naturalist and Geologist*, later published by the Natural History Society of Montreal, on which see also S. Sheets-Pyenson, "La vulgarisation scientifique dans le Canada du XIXe siècle: le *Canadian Naturalist*," in B.

two decades earlier in Britain, and he had experience with museums there. While resident in Swansea in the 1830s, Logan had become the honorary geological curator of that city's Philosophical and Literary Institution and a leading campaigner for a new building to display its natural history collections.[76] His ties to the Geological Survey of Great Britain had previously led him to contribute specimens and field notes to its Museum of Economic Geology in London.[77] He had even encouraged cooperation between this flagship metropolitan museum and its provincial counterpart in Swansea.[78]

In Canada, however, Logan's primary claim to fame as a geological curator stemmed from his more recent work: the display of Canadian economic minerals he had assembled and installed at the Great Exhibition of 1851, and his similar mineral display at the Paris exposition of 1855, mounted after the Select Committee had met and before Billings had been hired. In the report he filed in the aftermath of the Great Exhibition, he specifically identified London's Museum of Practical Geology (as the Museum of Economic Geology was by then known) as the institution that Canada's geological museum should imitate. Logan hoped to emulate the London museum's success as the

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Bensaude-Vincent & A. Rasmussen, eds., *La science populaire dans la presse et l'édition: XIXe et XXe siècles* (Paris: CNRS Editions, 1997): 207-215.

[76] W. E. Logan, "Report of the managing committee," [*Swansea Philosophical and Literary Institution*:] *Proceedings of the second annual meeting* (Swansea, 1837): 13-25, and subsequent reports to 1842; see also H. Torrens, "William Edmond Logan's geological apprenticeship in Britain 1831-1842," *Geoscience Canada* 26 (1999): 97-110. The society changed its name in 1839 to the Royal Institution of South Wales; the building survives today as the Swansea Museum.

[77] W. E. Logan to H. T. De la Beche, 5 Oct 1840; Logan to De la Beche, 3 Dec 1841, DBP. Logan's geological notebooks and papers for South Wales are in GSM 1/67 and GSM 1/218, BGS.

[78] 4 May, 18 May, and 31 May 1839; Council Minutes volume 1, Royal Institution of South Wales Records, Swansea Museum, City and County of Swansea. These minutes include transcripts of letters between British Survey director H. T. De la Beche and Logan, writing on behalf of the RISW.

popular and instructive arm of a national geological survey.[79] In short, Logan had a clear and credible vision of what his museum should accomplish; given sufficient resources, and the assistance of Billings, there was little doubt that he could produce a first-rate geological museum in Montreal.

Indeed, the Geological Survey of Great Britain served as an important model for its Canadian counterpart, if not in all respects (the conditions of fieldwork and mapping being so different), then certainly at least with regard to the communication of scientific knowledge through museum displays and in paleontological publications.[80] By 1857, the London museum even boasted a number of Canadian specimens, as guides published by keeper Robert Hunt and the British Survey's England director A. C. Ramsay show. The Canadian material included a wall case of minerals in the colonial section of the economically-useful products displayed on the ground floor, which mainly emphasized iron, lead, copper, and zinc ores, although earthy minerals and lignites were also to be found. The collection of lithological specimens, presented with additional stratigraphic information on the upper levels, included a group of granitic rocks from the Montreal area, which represented the problematic period below the Cambrian, still a geological problem because it had eluded description in the stratigraphic and paleontological terms used to define later periods. All of these specimens had been submitted and described by Logan, testifying to the real, though not exaggerated, level of intellectual and material

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[79] RP 1851, pp. 62-63. On the Museum of Practical Geology, see S. Knell, *The culture of English geology* (Burlington, VT: Ashgate, 2000), especially pp. 299-302. The name change was due to a move a new, purpose-built building. On De la Beche's intentions for the museum from 1835 onward, see the file in WORK 17/7/1, PRO.

[80] On the British survey's museum, see S. Forgan, "Brick and bones: architecture and science in Victorian Britain," in P. Galison & E. Thompson, eds., *The architecture of science* (Cambridge, MA: MIT Press, 1999): 181-208. On the specialist publications, see R. Cleevely, "John W. Salter, Sir William Logan, and Elkanah Billings."

interchange between Canada and Britain that continued to exist, despite the death of Henry De la Beche in 1855. In fact, Ramsay visited Logan's Canadian museum in Montreal in August 1857 (as discussed below), just a few months before he wrote the introduction to the catalogue of his own institution's collection.[81]

Elkanah Billings had joined the Survey in August 1856, and he worked for a solid year on the museum before beginning any fieldwork to expand the collections. In his first annual report, he described the museum arrangement that he and Logan had adopted: "the first floor has been selected for the exhibition of the economic minerals and rock specimens of the older formations, including the altered Silurian. On the second floor will be arranged the fossils of the Lower Silurian; while the third floor will be devoted to the Anticosti group or Middle Silurian, the Upper Silurian, Devonian, Carboniferous, and Drift."[82] True to Logan's plan, this layout was inspired by the British Geological Survey's Museum of Practical Geology in London.[83] However, within the broad group represented by the Lower Silurian fossils, which occupied an entire floor, Billings proposed to follow "as nearly as practicable," the division of this time period into seven subgroups, according to the classificatory system of New York state geologists. On the third floor, though, the arrangement was complicated by the fact that the rocks of these eras were not so neatly divided in eastern Canada (i.e., Quebec) as they were in New

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[81] R. Hunt, *A descriptive guide to Museum of Practical Geology* (London: Eyre & Spottiswoode for HMSO, 1857), see pp. 165-166; A. Ramsay et al., *A descriptive catalogue of the rock specimens in the Museum of Practical Geology* (London: Eyre & Spottiswoode for HMSO, 1858), see pp. 253-256.

[82] E. Billings, "Report for the year 1856," in RP 1853-54-55-56, p. 138.

[83] Knell, *Culture of English geology*, argues that while the main floor exhibits of economic and practical minerals supported the idea that the Survey was a valuable public service, the upper floors in fact continued an older provincial tradition of arranging fossils according to stratigraphic position, which was the scientific basis of geology.

York. Accordingly, the "table cases" containing the main fossil displays would reflect general groupings, while "wall cases" would follow the more specific arrangement of the New York system. In the table cases, fossils would also be laid out in "ascending order," from the simplest to the most complex forms of life: "A stratigraphical and zoological arrangement will thus be effected." Finally, the accuracy and authority of the exhibits would be testified to by labels that conveyed, not only the name of each fossil and of the "acknowledged author of the species," but also the locality from which it had been collected and the identity of the collector.

The main floor of the museum, displaying economic minerals, would be the first area that visitors encountered, underscoring the Survey's self-presentation as a fundamentally practical enterprise. Unlike the fossils on the floors above, these mineral exhibits were not arranged on a scientific system, such as chemical composition or physical structure. Instead, they were arranged according to their use in industry, or the products into which they could be made. The categories into which they were grouped ranged from "metals and their ores" to "mineral paints," "materials applicable to the fine arts," "refractory materials," "mineral manures," "materials applicable to common and decorative architecture," "combustible materials," and "minerals requiring more complicated chemical treatment to fit them for use."[84] This may sound like a miscellaneous hodge-podge, and Logan freely admitted that it was "not found in ordinary educational institutions."[85] Yet it was the system that Logan had first adopted for the Great Exhibition of 1851, as a result of the decree that raw materials there should be

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[84] See the pamphlet prepared around this time, W. Logan, "Catalogue of economic minerals of Canada for the Paris Industrial Exhibition" [Montreal, 1855], pp. 1-6.
[85] RP 1851, p. 63.

displayed in conjunction with their finished products.[86] The secret to Logan's success was that he simply ignored the fact that Canada had thus far made virtually no use of the valuable minerals his Geological Survey had identified; instead, by presenting the specimens under headings directly related to finished products – from fine jewelry and ceramics, to buildings and roads made of sturdy stone – he encouraged the belief that Canada was destined to enjoy such amenities in abundance in the years to come.

Indeed, Logan hoped that the prophecy embodied in such displays would work to achieve its own fulfillment, noting in his 1854 testimony that, in his opinion, "the London Exhibition was one of the most splendid and successful advertisements for Canada in regard to her Minerals and everything else that could have been contrived. She then became known to thousands upon thousands of just such people as she in various ways wants, who might otherwise never have dreamt of her resources."[87] Moreover, it was not only those who were unfamiliar with Canada who could be attracted to develop the colony's industrial potential. The Geological Survey's exhibits also played a crucial role in encouraging those who already lived in Canada to make the most of their mineral resources, as the fifteen thousand people who attended a Provincial Industrial Exhibition in Montreal in 1850 had learned. This event, held as prelude to the Great Exhibition, was described by the city's leading English-language newspaper as "the first occasion when the products of a country stretching from the sea to the limits of civilization ... have been assembled in one hall. It is the first time ... that the glorious country we inhabit, yes, own, as Britons, has been even faintly made known to ourselves, or that an attempt has

[86] "Report… on the Industrial Exhibition"; see also Zaslow, *Reading the rocks*, p. 68.
[87] SC, Logan, Q. 96.

been made to make it known to our countrymen at home."[88] In the Survey's renovated museum, scheduled to open in Montreal in 1857, such exhibits would be on permanent display for natives and visitors alike to see and learn from.

Another reason to hurry the completion of the museum's new exhibits was that August 1857 promised to witness the most important influx of scientific visitors in Montreal's history. The American Association for the Advancement of Science, a group originally founded by geologists, had decided to hold its annual meeting in Canada on the invitation of the Natural History Society of Montreal.[89] Logan was the chairman for local arrangements and worked furiously on all aspects of the meeting; mindful perhaps of Agassiz's reproachful letter to the Select Committee three years earlier, Logan decided it was "imperative" that he "place the Provincial collection ... in a condition to be fully appreciated by such men of science ... as might be present at the meeting."[90] He and Billings worked virtually around the clock to make sure that the museum was ready to open on time. The process of preparing the fossils for display involved casting and painting a custom-moulded plaster of Paris block to hold each specimen, as well as compiling and printing the detailed labels already mentioned.[91] By the time the meeting arrived, Logan was so ill from overwork that he actually missed several days of it, "quite

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[88] Montreal *Gazette*, 25 Oct 1850. This statement applied to the Provincial exhibition as a whole, but its theme of collection as a means of synoptic vision is exemplified by Logan's mineral display.
[89] On the AAAS (itself the direct descendant of a geological association), see S. Kohlstedt, *The formation of the American scientific community* (Urbana, IL: University of Illinois Press, 1976). On local arrangements, see J. W. Dawson to Logan, 3 August 1857, LP/MUA.
[90] RP 1857, p. 6. See also Harrington, *Life of Logan*, pp. 325-8.
[91] Billings, "Report for the year 1856," p. 139. For the autobiography of a long-serving museum assistant who joined the Survey in 1859, and took over most of these duties, see T. C. Weston, *Reminiscences among the rocks* (Toronto, 1899).

worn out with bodily and mental fatigue."[92] According to the *American Journal of Science*, however, his efforts had not been in vain, for "One of the principal objects of attraction in the city was the Geological Museum.... It was remarkable for the extent and variety of rock specimens, and the great number and beauty of the fossils; no geological survey on this or any other continent has been carried forward with greater energy or skill."[93]

From a scientific point of view, the visiting American geologists were most interested not in the economic minerals, which they also possessed in abundance, but in the fossil collections, which illuminated both the differences and similarities in the geological histories of Canada and the United States. Logan believed that the term "American" in American Association for the Advancement of Science should apply to the whole continent, and he had used the subdivisions developed by geological surveyors in New York State to classify many of the Canadian rocks.[94] But Canadian geology did not perfectly reproduce the New York formations; hence the need for parallel exhibitions in the table and wall cases on the upper floors of the museum. In addition, the meeting of the AAAS gave the Canadian Survey a chance to show off its latest discoveries, fossils of a "fauna hitherto unknown" from Anticosti Island that appeared to fill a gap in the

[92] A. C. Ramsay, Monday 17 August, 1857 Diary, 1/26, KGA/Ramsay, ICST. Ramsay noted that Logan was "much better" on Friday 21 August. Similarly, T. S. Hunt noted that Logan fell ill on 16 August, was unable to answer his correspondence for several days, and subsequently departed on the field trip to Canada West. Draft to R. Lewis, 26 September 1857, LP/MUA.
[93] Miscellaneous Intelligence, "Eleventh Meeting of the American Association," *American Journal of Science and Arts* 24, no. 71 (Sept. 1857), p. 301.
[94] Invoking "the disregard of science for national distinctions," see W. E. Logan to Governor-General E. W. Head, 25 July 1857, LP/MUA.

American geological record.[95] James Hall, as a leading New York paleontologist, had earlier inspected these fossils and declared that they opened a "new world."[96] Most importantly to Canadians, though, was that the Anticosti fossils provided a middle Silurian series to correspond with the lower and upper Silurian formations to which Logan had assigned many of the Canadian rocks mapped so far.

Silurian fossils were central to the Survey's presentation of Canada's geological structure: they occupied the entire second floor of the geological museum, and much of the third. The Silurian system, as described by its discoverer Sir Roderick Murchison, a prominent British geologist, referred to the rocks containing the oldest known forms of life. It was among the best-known geological eras, thanks to Murchison's tireless pen, but it was also, for geologists, one of the most controversial.[97] By defining his Siluria broadly, Murchison, who from 1855 was director of the Geological Survey of Great Britain, was able to claim huge territories for the system around the world. Murchison chose not to attend the Montreal meeting himself, but sent his deputy A. C. Ramsay, who upon returning home noted of his debriefing session with Murchison: "Talked all day. The first and last words almost I heard were that confounded Siluria. He makes the Survey subservient to it."[98] In 1867, Murchison would dedicate the fourth edition of his

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[95] Billings, Report, p. 250. Anticosti is the large island located where the St. Lawrence River widens into the Gulf of St. Lawrence.

[96] W. E. Logan to J. W. Salter, M/L12/1, Murchison Papers, Geological Society of London.

[97] J. Secord, *Controversy in Victorian geology: the Cambrian-Silurian dispute* (Princeton NJ: Princeton University Press, 1986); M. Rudwick, *The great Devonian controversy* (Chicago: University of Chicago Press, 1985).

[98] Ramsay, Diary, 24 October 1857. Ramsay and Logan were old friends, and together with James Hall they went on extended field trip of Canada and New York after the meeting. See also R. I. Murchison to Logan, 7 July 1857, and A. C. Ramsay to Logan, 8 July 1857, both LP/MUA.

definitive *Siluria* to William Logan, in recognition of the Canadian Survey's application of that system across British North America.

The connections between Murchison and imperialism (both opportunistic and overt) have been well explored; the implications for Canada are not so much that a British system was imposed on its geology, but that Logan helped Canadians to participate in the empire by allowing them to see their land in the same terms that Britain itself was defined.[99] The identification of various Canadian strata as Silurian had begun with distinguished geologists like Charles Lyell in the early 1840s, soon after the system was first described; it spread to military officers by 1849, as Murchison reached the height of his fame; and by 1860 it was entrenched in popular consciousness, appearing in settlers' guides to Canada and travel letters by enthusiastic amateurs.[100] One valuable by-product of completing the museum displays in 1857 was that the Survey could finally set aside large collections of duplicates for distribution to educational institutions in other Canadian cities, thus physically reproducing the representation of the colony's geology, and making it visible to audiences across the province.[101] In this context, Logan's

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[99] Murchison was also frequently President of the Royal Geographical Society, a key sponsor of imperial exploration, during this period. J. Secord, "King of Siluria: Roderick Murchison and the imperial theme in nineteenth-century British geology," *Victorian Studies* 25 (1982): 413-442; R. Stafford, *Scientist of empire* (Cambridge: Cambridge University Press, 1989), especially pp. 64-68. Stafford's metropolitan perspective leaves him largely oblivious to local agendas. An alternative view is offered by S. Zeller, "The colonial world as a geological metaphor: strata(gems) of empire in Victorian Canada," in R. MacLeod, ed., *Nature and empire: science and the colonial enterprise*, *Osiris* (2nd series) 15 (2000), 85-107.

[100] C. Lyell, *Travels in North America, Canada, and Nova Scotia, with geological observations* (London: John Murray, 1845; 2nd edition, 1855); J. E. Alexander, *L'Acadie* (London, 1849), p. 74; R. H. Bonnycastle, *Canada and the Canadians* (London, 1849), p. 76; Amelia Murray, *Letters from the United States, Cuba and Canada* (New York, 1856), p. 86; Catherine Parr Traill, ed., *The Canadian settler's guide* (London, 1860), p. 114.

[101] RP 1857, p. 6.

reference to the Silurian system throughout the Survey's work, most publicly and most visibly in these museum exhibits, was another contribution to the process of Canadian self-definition in multiple terms.

Logan's success in convincing Canadian colonial politicians to renew the Survey's funding again and again should not be taken for granted. A major reason for that success was his ability to produce results that engaged a variety of audiences, avoiding the trap of pleasing some people while alienating others. This was possible because of the fundamental plurality of Canadian identity. If historians might sometimes be reluctant to interpret the settler population as really part of a British empire, focusing instead on the many differences in circumstance that caused colony and motherland to diverge, the fact that Canada (much) later achieved independent nationhood should not obscure the attitudes and beliefs of an earlier epoch.[102] As the current episode affirms, it is not useful to create a dichotomy between nineteenth-century Canadian and British identities, to talk about them as if any increase in one must be a decrease in the other.[103] The exhibits in the geological museum showed how Canada was simultaneously a unique

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[102] For the history of science, see R. Jarrell, "British scientific institutions and Canada: the rhetoric and the reality," *Transactions of the Royal Society of Canada*, ser. 4, 20 (1982): 533-547. However, a very useful assessment of the cultural context is S. Zeller, "'Merchants of Light': the culture of science in Daniel Wilson's Ontario, 1853-1892," in E. Hulse, ed., *Thinking with both hands: Sir Daniel Wilson in the old world and the new* (Toronto: University of Toronto Press, 1999), 115-138. A classic work on (certain) Canadian attitudes to Britain and empire is C. Berger, *The sense of power* (Toronto: University of Toronto Press, 1970); on the transatlantic intellectual context see A. B. McKillop, *A disciplined intelligence* (Montreal & Kingston: McGill-Queen's University Press, 1979).

[103] Phillip Buckner is one of the few Canadian historians to pursue this position. See P. Buckner, "Was there a 'British' empire? *The Oxford History of the British Empire* from a Canadian perspective," *Acadiensis* 32.1 (Autumn 2002): 110-28; and P. Buckner, "Whatever happened to the British Empire?" *Journal of the Canadian Historical Association*, n.s. 3 (1994): 1-31.

place, and highly similar to its American neighbour, and part of a global British past, and bound for future industrial independence.

Like the geology of Canada itself, colonial Canadian identity existed in layers; it had its own stratigraphy, different elements of which broke through to the surface in different places and at different times. Context determined whether Canadian geology was best described as British, American, provincial, metropolitan, or irreducibly native and unique unto itself.[104] William Logan – Sir William – was one of the highest-profile Canadians of his time, especially among scientists and explorers, thanks to his productivity at home and his prestige abroad. This cultural authority, combined with his status as both a Canadian and a Briton, allowed him to freely use imported geological systems (the New York system, the Silurian system) without compromising his independence. The minerals and fossils on display in Montreal could embody more than one of these systems, and have multiple meanings for multiple audiences. Thus, while the reports, maps, and museum exhibits produced by Logan's Geological Survey helped to articulate Canadian national identity in the decades just before Confederation, this was not a hegemonic, mythic identity, mobilized to a single end or creating a binary opposition of inclusion and exclusion. Rather, the Geological Survey of Canada, especially though its public face, the museum, held a mirror up to colonial Canadians, inviting them to see in their rocks the multifaceted and polyvalent identities that they also saw in themselves.

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[104] For a similar idea, see M. Morgan, *National identities and travel in Victorian Britain* (Basingstoke: Palgrave, 2001).

CHAPTER 6

Maps of Future Places

A series of related issues come together in this chapter, all following under the more general heading of how Logan's audiences – whether the provincial government or the public at large – absorbed, internalized, and employed the geological facts that, having brought into being, he put at their disposal. In doing so, this chapter continues directly from the previous one, in being concerned above all with the GSC's public products and their impacts in Logan's own era, but it also reaches out into more distant terrain, ultimately raising more ambitious questions about the Survey's implication in Canadian identity in the much longer term.

To begin, we briefly recall the first "practical" assignment that Logan was given, to examine the putative mining areas on the north shores of Lakes Superior and Huron in 1846 and 1848. This work was important in formalizing the colonial government's attitudes to land administration, and in that sense directly supported the negotiation of the significant Robinson Treaties in 1850. Second, we broach the much larger question of Logan's geological maps, which were at once the most sophisticated and most reductive of the Geological Survey's products. They demanded a great deal of preparation on the part of geologists, and yet could be grasped quickly by a wide range of users. What the two subjects have in common is their consequences for the unsettled, undeveloped northern regions of the Province of Canada (and soon afterwards for the Dominion as well). In both cases – whether writing about the land as a potential mineral resource, or in creating all-encompassing maps more generally – Logan's survey paved the way for a Canada that would eventually range much farther than the one he had first been asked to map in 1842.

In an important sense, it is hardly surprising that the Canadian colonial government took up and made use of the early results of Logan's Geological Survey. That had, of course, been the original goal and indeed the rationale for funding the institution of a survey in the first place. Thus after Logan's first two summers in the Gaspé peninsula (chapters 3 and 4), a region chosen according to his own geological instincts and curiosity, he found himself summarily assigned in 1846 to examine prospective mining regions on the north shore of Lake Superior. A speculative copper boom in this remote area, carrying over from the U.S. side, posed a serious problem for colonial authorities, who up to that point had little means of bringing the territory under administrative control – Logan's survey was the sole body capable of exploring, mapping, and generating credible expert knowledge about these little-known lands. His report gave authoritative geological assessments of twenty-seven specific localities, tied to a Provincial Land Surveyor's map.[1] Subsequently, in 1848, he went to the Bruce Mines area on the north shore of Lake Huron, another region of great interest to

[1] W. Logan, "Report prior to his explorations on Lake Superior" (no. 5), and W. Logan, "Report after his explorations on the shores of Lake Superior" (no. 6), in App. AAA, JLA 1847. Notably, the first of these two reports was the longer, and it drew on H. T. De la Beche's data from Cornwall in its discussion of the possible nature and value of Canadian ores. For the expedition itself, see W. Logan, "Lake Superior" [1846], Field Notebook 1970, vol. 158, RG 45, LAC; and W. Logan, 1846 Journal, TPL; these two manuscript resources (both now available online) would support a very detailed investigation. On the various copper mining companies implicated in the region, one of which involved Logan's brother James, see S. Zeller, *Inventing Canada* (Toronto: University of Toronto Press, 1987), pp. 66-71. On the presentation and employment of statistics in government reports, see B. Curtis, "Textual economies and the presentation of textual material: charts, tables, and texts in 19th century public education," *Scientia Canadensis* 29 (2006): 3-28.

prospectors and speculators alike. Logan's detailed report included a long narrative discussion as well as quantitative accounts of many specific mine shafts at Bruce Mines and the results of analyses conducted on ore samples taken at each one, thus putting a wealth of hard, place-specific data into the hands of government administrators.[2]

Located well beyond the European-settled part of Canadian territory, the colonial presence in the upper Great Lakes had previously amounted to no more than a few isolated Indian agents. All this changed in 1849 with the "Mica Bay incident," which saw a group of Ojibway invade and take temporary control of a mining operation.[3] The rapid abandonment of government indifference to this northern region was marked in 1850 by the negotiation of the Robinson treaties, which paid attention for the first time to the questions of mineral rights.[4] Thus, Natives retained the ability to benefit from mineral resources found on their reserve lands, in exchange for promising not to disturb

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[2] GSC, "Report on the north shore of Lake Huron," App. G, JLA 1849. The ore sample assays in this fifteen-page report were conducted by the GSC's new chemist, T. S. Hunt. The relevant field notebook is W. Logan, "North shore of Lake Huron" [1848], FN 1972, vol. 159, RG 45, LAC; however, it mainly contains data relating to topographical calculations and to Bruce Mines. See also J. Mouat, *Metal mining in Canada, 1840-1950* (Ottawa: National Museum of Science and Technology, 2000), pp. 21-26; and W. Wightman & N. Wightman, *The land between: northwestern Ontario resource development, 1800 to the 1990s* (Toronto: University of Toronto Press, 1997).

[3] See A. Knight & J. Chute, "A visionary on the edge: Allan Macdonell and the championing of native resource rights," in C. Haig-Brown and D. A. Nock, eds., *With good intentions* (Vancouver: UBC Press, 2006), pp. 87-105; N. Wightman & W. Wightman, "The Mica Bay affair: conflict on the upper-lakes mining frontier, 1840-1850," *Ontario History* 83 (1991): 193-208; and E. Arthur, "Beyond Superior: Ontario's new-found land," in R. Hall et al., eds., *Patterns of the past* (Toronto: Dundurn Press, 1988), pp. 130-149, especially pp. 134-136.

[4] R. Surtees, "Treaty Research Report: The Robinson Treaties (1850)," (Ottawa: Indian and Northern Affairs Canada, 1986); J. Chute, *The legacy of Shingwaukonse* (Toronto: University of Toronto Press, 1998), pp. 410-413. For the broader context of these treaties, which covered territory right up to the colony's boundary (with Rupert's Land), including more land than all other cessations in Upper Canada combined, see A. Ray, *I have lived here since the world began* (Toronto: Lester/Key Porter, 1996), p. 156.

mining activities elsewhere.[5] Amounting essentially to a permanent Native renunciation of lands on the north shores of both Lakes Superior and Huron, this major expansionary initiative on the part of the colonial government had been directly underwritten – materially, administratively, and above all epistemologically – by Logan's geological survey. Not insignificantly, the treaty negotiator himself, William Benjamin Robinson, had friendly personal and family ties with Logan in later years.[6] As for Logan, it was in performing this practically-oriented work in response to short-term exigencies that he developed his passion for the Laurentian and Huronian formations, which would shape much of the rest of his research in Canada. Thus, this short-lived mining boom during the second half of the 1840s served well to foreshadow the enormous role that the GSC would have in defining and imaging Canada's north in the remaining decades of Logan's tenure, throughout the late nineteenth century, and indeed well into the twentieth.

6.1 Of Borders and Transparency

When it comes to tying scientific knowledge to specific places, the supreme tool is of course the geological map, a sadly underused source in the history of science. While

[5] See also J. Chute & A. Knight, "Taking up the torch: Simon J. Dawson and the upper Great Lakes' native resource campaign of the 1860s and 1870s," in C. Haig-Brown & D. Nock, eds., *With good intentions: Euro-Canadian and aboriginal relations in colonial Canada* (Vancouver: University of British Columbia Press, 2006), 106-131.
[6] Indeed, it is evident from later correspondence that Logan and the treaty negotiator (and fur trader and Tory politician; see DCB) William Benjamin Robinson (1797-1873) were personal friends, but the date of origin and full implications of this relationship await further investigation. See, for two examples, a dinner invitation and a longer discussion of political affairs, touching both on Robinson's career and on the renewal of the GSC's funding; W. B. Robinson to Logan, 1 April 1856 and 5 June 1856, LP/MUA. On the politically powerful Robinson family, see P. Brode, *Sir John Beverley Robinson* (Toronto: Osgoode Society/University of Toronto Press, 1984); according to which W.B.R. was a "not very bookish but lively and talented frontier entrepreneur" (p. 101).

there is a burgeoning literature in the history of cartography, much of which is relevant to the geographical sciences, very little has been published on specifically geological maps.[7] One reason for this is that the community of historians of geology is relatively small, and within it, geological surveys have received relatively little attention. However, as the case of Logan shows, this neglect is entirely misplaced. To begin with, his maps combine important qualities of his textual reports and his material displays; but in doing so, they go far beyond them both as well.

Like written reports, maps are printed and thus have a permanence and portability that exhibits lack. They can be reproduced in large numbers (although, in an era before reliable high-quality colour printing, not arbitrarily large). They can be procured and studied by interested parties distant in time or space from the original. However, like exhibits and displays, maps are basically visual rather than textual in nature. Executed on a large scale, they can themselves be objects of display, accessible to passing visitors. Like collections of artifacts, maps present information rapidly and efficiently, and by making use of spatial arrangement, bring an order and meaning to the data not available in a written descriptive list.

This dual nature of geological maps means that they are among the most important of Logan's undertakings, for practical reasons in addition to the conceptual ones just mentioned. A geological map of Canada accompanied Logan's displays of

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[7] For examples of outlines of technical and regional case studies, see E. Dudich, ed., *Contributions to the history of geological mapping* (Budapest: Akadémiai Kiadó, 1984). See also J. B. Harley, "The Ordnance Survey and the origins of official geological mapping in Devon and Cornwall," in K. J. Gregory & W. L. D. Ravenhill, eds., *Exeter essays in geography: in honour of Arthur Davies* (Exeter: University of Exeter, 1971), 105-124. An important core work is M. Rudwick, "The emergence of a visual language for geological science 1760-1840," *History of Science* 14 (1976): 149-195.

Canadian minerals at International Exhibitions, most famously in 1851 in London and 1855 in Paris, and was thus seen by the tens of thousands of visitors who ventured into the colonial sections of those fairs. In print, an atlas volume accompanied the massive 1863 monograph, *Geology of Canada*, and Logan's work formed the basis of Survey maps well after his retirement. As a result, it seems clear that Logan's maps were almost certainly the most widely seen fruits of the early Geological Survey of Canada. The number of people who encountered one of his geological maps, either in an exhibition or in a printed form, must have greatly exceeded that who actually read his Reports of Progress, buried in the appendices to the Journals of the Legislative Assembly. Far from being peripheral, secondary, or derivative, then, it is arguably to the maps that we should turn first in seeking to understand the meaning and impact of the Geological Survey of Canada.

Despite their importance for our purposes, maps were the last to be produced, of the three kinds of scientific products. Logan's written reports were published from 1845, and collections of rocks and fossils were exhibited at the Survey's Montreal headquarters even before the London Exhibition of 1851. The relatively late production of geological maps is ironic because it was primarily upon mapping that Logan had established his geological reputation in Britain in the late 1830s. After all, when he had been based in Swansea, he had undertaken to survey the great South Wales coal fields in the neighbouring area, and recorded his minutely detailed observations on the existing Ordnance Survey topographical maps. Logan's geological cartography set new standards of precision, and after he exhibited his South Wales map at the 1837 meeting of the

British Association for the Advancement of Science in Liverpool, his work was adopted enthusiastically by the Geological Survey of Great Britain.

Thus, when Logan had been proposed for the Canadian Survey, his British referees had all mentioned first and foremost his survey of South Wales, and in particular the excellence of his map. While it has long been recognized that Logan was hired in large part for his expertise on coal, which the Canadian government was so concerned to locate, it also would have been reasonable to expect that he would have produced geological maps of Canada within a few years. He did not, because the conditions of mapping were so different in Canada from Britain. Instead of having a detailed, consistent series of trigonometrically-surveyed topographical maps to work from, Logan had only partial charts and plans to work from, produced by many different workers at different times, using different techniques and for different ends. In Britain, geological mapping meant adding geological details to the existing map. In Canada, it meant creating the map first, either by reconciling disparate bits and pieces, or by conducting a topographical survey from scratch.

The challenge that Logan faced in this respect is well known, but worth reiterating to explain why maps were last of his scientific results to appear. They were intrinsically difficult to assemble, laborious and time-consuming. Rather than being an afterthought, however, Logan's drive to produce a geological map of Canada, the neighbouring British North American colonies, and the northeastern United States, should be seen as the culmination of the work of the Geological Survey. Certainly, when the Survey's progress was evaluated by a parliamentary Select Committee in 1854, the publication of a map was seen as a key desideratum.[8]

From the early nineteenth century onward, the geological survey and the geological map evolved as interlinked technologies, designed to solve two closely related problems. In the most basic terms, the survey solved the problem of how reliable environmental knowledge could be produced, while the map addressed the problem of how such knowledge was to be distributed.[9] By environmental knowledge, I mean knowledge that had two distinct and equally-significant aspects: scientific names and concepts were applied to specific geographical space. The survey answered the question of how consistent and coherent observations could be made over a wide territory, by combining a geologist's firsthand field experience with detailed topographical mapping, whether pre-existing or made concurrently. British geologists had the luxury of simply adding geological colours to the high-resolution trigonometrically-surveyed maps produced by the Board of Ordnance. Canadian geologists, at least in the nineteenth century, had to do their own topographic base mapping as they went long, since existing land surveys were piecemeal, technically inadequate, and covered only a small proportion of the colony's territory. It says something about the enthusiasm for economically useful science in Victorian Canada that the colonial Legislative Assembly funded a geological

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[8] J. Langton, "Report of Select Committee," Appendix L, JLA 1854-5.
[9] A good introduction to the importance of mapping ("a multiply theoretical activity") in early nineteenth-century British and European geology is R. Laudan, *From mineralogy to geology* (Chicago: University of Chicago Press, 1987); see especially pp. 161-170, quoting p. 162. The U.S. case is broached in C. Nelson, "Toward a reliable geologic map of the United States, 1803-1893," in E. Carter, ed., *Surveying the record* (Philadelphia: American Philosophical Society, 1999), pp. 51-74, which generally shows that contemporary American maps were smaller and less detailed than Logan's. For a broader historical context, see also R. Kain & E. Baigent, *The cadastral map in the service of the state* (Chicago: University of Chicago Press, 1993).

survey from 1842 onwards, long before the establishment of a national topographic surveying program.

So, if the point of a survey is to add geological knowledge to topographical data, what does a geologically-coloured map mean? The map's single most salient feature is that it does not simply show only what the geologist observed: an outcrop here and there, exposures along the coast, or a linear traverse across the countryside. Instead, by applying colour uniformly over the land, it makes an equal knowledge claim for every single point in a given zone.[10] Every spot is assigned to a geological formation, and everywhere within that formation is equal. Like all maps, the geological map offers a visual transparency in that it permits the observer to engage in a total vision from a disembodied perspective, and imagine that the object of vision is not the map but the land itself. It brings together the observations of various surveyors in various places at various times, and presents an image that can be studied by anyone in any place at any time. But the geological map even goes one better, because it also purports to make surface of the land transparent too, effecting an impossible vision of the inferred, invisible, three-dimensional structure of subterranean strata. The bedrock formations depicted on geological maps are in the field nearly always covered by vegetation or loose recent deposits. The view thus represented on paper is a highly-idealized abstraction; it is far better than any real view could ever be, no matter how perfect.

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[10] By the end of the nineteenth century, more attention was beginning to be paid to the importance of distinguishing between observation and inference, as in the work of British geologist Edward Greenly. A. Maltman, *Geological maps* (New York: John Wiley & Sons, 1998), pp. 207-210. However, such distinctions require mapping at a resolution about two orders of magnitude better than Canadian geologists could pursue in the mid-nineteenth century (six inches to the mile versus one inch to twenty-five miles).

Again, what makes this special vision possible is the fact that the map is entirely covered by geology; every point belongs to some formation or another. Given that the vast majority of points are never actually observed by the surveyor, it is evident that the crucial objects of knowledge established by field work are boundaries. When you trace the boundaries of a formation on the map, you claim to know something about every single point within those boundaries. And that knowledge claim is the foundation of the map's power, at least, as in the present example, when it comes to a small-scale map of a large piece of colonial territory, intended to impress a broad audience with its economic predictive power. Once the basic outlines of a region's geology were known, after a fairly rapid reconnaissance, such as the oldest and youngest rocks it contained and the controlling structural features of the deposits, the main function of subsequent surveyors was to locate and trace the natural boundaries between identified formations. What concerns us, then, is the question of how knowledge gathered in the field, in very limited and specific places, was transformed into the broadly generalized knowledge that was represented on the map.[11]

It is important to realize that environmental knowledge differed considerably in its field and finished forms. The lithological, paleontological, structural, and topographic uncertainties that were inherent in field work, especially when that field was the rugged, uncharted Canadian wilderness, had no place in the published map, which represented all facts equally with its unambiguous clearly-delineated colours. However, such

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[11] A highly influential approach in science studies relating to this type of problem is Bruno Latour's concepts of action at a distance, immutable mobiles, and centres of calculation: B. Latour, *Science in action* (Cambridge, MA: Harvard University Press, 1987), pp. 223-228, 233-237. For an example specific to the earth science, see his analysis of Amazon soil research in *Pandora's hope* (Cambridge, MA: Harvard University Press, 1999), chap. 2.

transformations did not necessarily happen quickly. The Geological Survey of Canada, despite its beginning in 1842, did not publish a large general map until the very end of the 1860s. In its early first years, Logan and Murray were the only two geologists, and they often worked separately. This was largely reconnaissance work, restricted to rivers, coastlines, and settled areas. By the mid-1850s, however, several kinds of preliminary maps were being produced.[12]

The first of these was in fact of whole series of sheets in a special folio volume, printed to illustrate several years' worth of expeditions, mostly led by assistant geologist Alexander Murray, in the Ottawa-Huron tract, a particularly challenging territory at the time.[13] The rocks in this area, located just north of the settled parts of what is now southern Ontario, were not the familiar, flat, well-stratified sedimentary rocks that contemporary geological surveying required in order to have predictive power. Instead, they were highly contorted, metamorphosed, crystalline rocks whose stratigraphy was essentially unanalyzable, if even perceptible. Nevertheless, the region was of prime interest to the colonial government as the only substantial remaining territory for agricultural settlement (see discussion later in this chapter). Although these lands had previously been seen as granitic, and thus barren, the Geological Survey set out to examine the region in the hopes of reaching a more encouraging conclusion about its

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[12] P. von Bitter, "Sir William Logan's geological maps of Canada," *Map Collector* 68 (1994): 12-18; this article also discusses a few occasional maps produced to illustrate scientific journal publications, which I do not examine in this chapter.

[13] Geological Survey of Canada, *Plans of various lakes and rivers between Lake Huron and the River Ottawa, to accompany the geological reports for 1853-54-55-56* (Toronto, 1857). Many library copies of this volume exist, but they are very fragile, generally in poor condition, and have received little historical attention; they are among the only printed GSC sources not yet digitized. The maps, folded multiple times, were printed on 22 x 33-inch sheets of thin and now brittle paper.

economic prospects. The reports of Murray's explorations formed a central part of the Survey's 286-page volume for the years 1853-56, which the atlas accompanied. "All of the Maps," the introduction clearly states, "are required for the proper understanding the Reports."[14]

A description of a typical example, taken from the first sheet of exploration maps, illustrates their hybrid nature. First, the map shows topographic data, the physical shape of the river, an accurate survey of which was one of the primary goals of these expeditions.[15] At a scale of one mile to the inch, these maps were much more detailed than any of the other Canadian geological maps of the time, but still fairly crude by European standards. Second, it shows geological information, but not by means of named formations and coloured territories. Instead, it depicts local geological features as they were encountered, without making any claims about their place in larger structures: "micaceous slates"; "micaceous and quartzose slates inter-stratified with beds of quartzite and some layers of greenstone with large quartz veins"; "slightly chloritic slates and trap with calcareous veins"; "trap dyke 120 yards wide." These qualitative descriptions are accompanied by quantitative measurements of dip and strike, crucial numbers that revealed the three-dimensional geometry of the strata: towards south 25 degrees east, inclined at an angle of 58 degrees; and a little father along, the same direction, south 25 degrees east, but at an angle slightly less steep, 42 degrees. This type of information was needed to infer whether one bed overlay or underlay another one, and thus was crucial in

[14] RP 1853-54-55-56, p. [2].

[15] GSC, *Plans*, Sheet 1, Topographical Plan of Spanish River, A. Murray, 1848. The large format of these maps, combined with their minute level of detail, unfortunately makes it impossible to reproduce them here at any legible scale of reduction.

determining the formation to which territory with no visible or accessible outcrops should be assigned.

By showing these measurements at specific points, indicated by arrows, the printed map also verified the surveyors' physical presence in the field. The source of the reliability of their knowledge was itself mapped: "Camp. September 23, 24," along with a careful latitude determination at seconds-level resolution. Also mapped were transitory (temporary, or season-dependent) features of their experience on the river: Rapids, "slight current," "current pretty strong." Murray's charts display environmental knowledge in its field form, existing only at specific points that were observed by specific surveyors on specific days. Given the little-known territory through which he was travelling (since he was conducting the topographic surveying for this region as well), the inclusion of these details on the map lent it more authority than it otherwise would have had. Working in an area without easy natural boundaries between recognizable geological formations, it was impossible at this time to assign broad swaths of colour to the land. Instead, the coverage was necessarily partial, limited to the banks of just a few rivers in the wilderness.

The second type of intermediate map Logan published, however, was a true geological map, in full colour, produced by hand for the Paris international exposition of 1855. It was then published, at the rather small scale of roughly 150 miles to 1 inch, in the official catalogue of the Canadian exhibits, accompanied by a sizeable essay.[16] At the time, the colour printing technique of chromo-lithography was quite new – geological

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[16] T. S. Hunt, ed., *Esquisse géologique du Canada / A sketch of the geology of Canada, serving to explain the geological map and the collection of economic minerals* (Paris, 1855). The 29 cm x 12 cm map was included in the French edition, but omitted from (at least some copies of) the English edition, according to my research experience.

maps had previously been hand-coloured, allowing for much finer degrees of shading, and better control over the shades used for related rock types.[17] Some of Logan's identifications were still evolving at this point. For example, he placed his Huronian formation (now classed as part of the Precambrian) into the Cambrian system, a geological era whose limits were the subject of a famously acrimonious debate between Adam Sedgwick and Roderick Murchison.[18] Nevertheless, the Paris map was a potent item; as undeniably impressive evidence of Logan's success in Canada, it was one of the factors that led to his knighthood shortly after the Exposition came to a close.

In his testimony before the Select Committee in 1854 (see chapter 5), Logan had already articulated the link between mapping and transparency, the idea that a geological map gave one the power literally to see through the surface of the earth to what would otherwise be invisible:

> Accurate topography is the foundation of accurate geology.... Without geographical position, ... the occurrence of a valuable mineral in two localities distant from one another are just two isolated, unrelated facts; while their topographical place being known, their dip and strike may immediately point to the probability, and guide to the search and discovery of the same substance in a hundred places in between.[19]

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[17] K. Cook, "From false starts to firm beginnings: early colour printing of geological maps," *Imago Mundi* 47 (1995): 155-172. On early colour lithographed maps in the Canadian context, see also J. Murray, *Terra nostra* (Montreal & Kingston: McGill-Queen's University Press, 2006), pp. 78-79.

[18] The subject of J. Secord, *Controversy in Victorian geology* (Princeton, NJ: Princeton University Press, 1986).

[19] Question 70 (W. Logan), in J. Langton, "Report of Select Committee," Appendix L, JLA 1854-5; also quoted in B. J. Harrington, *Life of Sir William E. Logan* (Montreal: Dawson Brothers, 1883), pp. 284-5.

Now, in the context of the exhibition of Canadian economic minerals, Logan elaborated on that theme, saying he had endeavored to:

> convince the world that Canada contained in her subsoil vast stores of mineral materials that would hereafter become available for the support of native industry. The mere specimens exhibited, however, would have been an ineffectual means of attaining the object had they not been accompanied by a geological map showing that geographical distribution of the formations from which the minerals were derived – thus making at once intelligible the position and abundance of those things of which the specimens merely displayed the nature.[20]

Clearly, then, if the topography of formations was the key to the transparency – location in the subsoil – of industrial resources, what was required was the improved mapping of individual formations.

The general topographic base for the Paris map, which depicted not only Canada but the other British North American colonies and the neighboring U.S. states, had been hurriedly constructed by joining together a number of different maps of the various areas. Although the finished product, which received great acclaim, was originally intended to be the template for the published map that the Survey was mandated to provide, it turned out that "a more leisurely comparison of the topography with original surveys" revealed a number of major distortions in the longitudes of eastern and western points, and the decision was made "to abandon the map and undertake the construction of another from

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[20] Quoted in Harrington, *Life of Logan*, pp. 321 f. This was on the occasion of the presentation of an ornate silver fountain (now lost) to Logan by the people of Montreal in March 1859.

original documents."[21] The longitude problems were solved by using the telegraph to send signals between astronomical observatories in major Canadian towns and U.S. cities, thus allowing their true relative location to be fixed. This was completed fairly quickly, but before the revised map was produced, new geological field work was undertaken. Thus, the period between 1856 and 1869 was characterized less by general exploration, and more by work on specific problems to fill in gaps on the geological map.[22]

The next major advance was the publication in 1865 of the *Atlas of Maps and Sections*, the long-awaited companion volume to his magnum opus, the *Geology of Canada.*[23] It had taken a full decade to go from the published Paris map to the general index map (dated 1864) appearing in the *Atlas*, which was really the first to be issued as an official publication of the Survey (figure 1; all figures at end of chapter). As highly-praised as the Paris map had been, Logan was not satisfied with it, and declined to allow it to serve as the map that had been asked for by the Select Committee. Instead, he embarked on an ambitious project of revision that centred on a collaboration with Lt. Edward D. Ashe of the Quebec Observatory. Borrowing an idea from the U.S. Coastal Survey under A. D. Bache, Logan and Ashe used telegraph communication technology to

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[21] RP 1853-56, pp. 30-33.
[22] M. Zaslow, *Reading the rocks* (Toronto: Macmillan, 1975), p. 68. See the invaluable D. Dowling, "A condensed summary of the field-work annually accomplished by the officers of the Geological Survey of Canada from its commencement to 1865," *Ottawa Naturalist* 24.6 (1900): 107-118.
[23] Geological Survey of Canada, *Report of progress from its commencement to 1863, Atlas of maps and sections* (Montreal: Dawson Brothers, 1865). The Toronto *Globe*, for example, had specifically anticipated maps, "engraved on steel or copper, and printed in oil colours by chromo-lithography," "which will be of such value to the student of Canadian geology." "Geological Survey of Canada," *Globe*, 26 December 1863, p. 2; ibid., 3 February 1864, p. 2.

compare the times of astronomical phenomena (star transits) in different cities, thus permitting a very precise determination of their relative longitude.[24] This was not as easy as it sounded – it was the first time such a demanding undertaking had been attempted, and Ashe had to deal with problems ranging from rock-throwing boys in Kingston, to the small matter of finding a way to string wire over the two miles between the Magnetic Observatory and the telegraph office in Toronto, in the middle of January.[25] Nevertheless, by comparing Trois-Rivières, Montreal, Kingston, Ottawa, Toronto, Collingwood, Windsor, and Chicago to Quebec, and by comparing Quebec, Fredericton, and Halifax to Cambridge, Massachusetts, it was possible to reconcile dozens of regional maps into a continental composite with unprecedented accuracy. In an important sense, Canadian topography had been defragmented, and its regional elements made more closely commensurable with each other. The position of the Quebec Observatory itself was modified by 14 seconds as a result of this exercise, and significantly, it had all been instigated by Logan.[26] This certainly gave the impression that the Geological Survey was

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[24] On Bache, whose project was comparable to Logan's in being an example of federal government science (the U.S. Geological Survey was not founded until 1879), see H. Slotten, *Patronage, practice, and the culture of American science: Alexander Dallas Bache and the U.S. coast survey* (Cambridge: Cambridge University Press, 1994); see also A. Bache to Logan, 18 September 1856, LP/MUA, regarding the longitude of Chicago.

On Ashe (1813-1895, DCB), see his report to Logan, "On the longitude of some of the principal places in Canada, as determined by the electric telegraph in the years 1856-57," in RP 1857: 137-140 (a manuscript version under the same title also exists in box 2, Logan manuscripts, ESIC); E. Ashe to Logan, 8 September 1856, LP/MUA (and related items in the same collection); see also R. Jarrell, *The cold light of dawn* (Toronto: University of Toronto Press, 1988), chap. 2.

[25] Ashe, "On the longitude," p. 138.

[26] Ashe, "On the longitude," p. 140; here Ashe avowed that "the ease and accuracy with which the position of a place can now be fixed … renders it imperative that all those places which can avail themselves of the use of the telegraph lines, should have their longitudes determined at once, in order that a correct map of Canada may be produced."

both the most sophisticated and most demanding of government scientific enterprises, further enhancing the perceived reliability of its results.

Another notable feature of this map is that it was produced in London in conjunction with the British Geological Survey, and care was taken to use the same colour scheme for Canadian rock formation as was currently in use on British maps.[27] This is a case in which imperial ideas and values explicitly found their way into practice, although with perhaps limited impact. Thus, in reviewing the 1865 *Atlas*, the *Athenaeum* of London remarked that the maps "are much too small for general study, though they may and will convey general ideas to a reader endowed with microscopic vision and a high magnifying power of mind. In the Canadian series of rocks the interest is principally local and lithological. At home we see but little to interest us."[28] In any case, Logan turned to a new approach in the production of his next and final map.

Logan's great general map of 1869 (dated 1866) was his crowning achievement. Although this was in fact prepared from the same base map as the previous one, albeit at a scale five times larger (25 miles to 1 inch, instead of 125 miles, and thus still what would be considered low-scale by European standards), the colour scheme was quite different, although the colour has unfortunately not aged well in the few extant copies.[29] Colour printing was still not feasible for such large (253 cm x 105 cm) maps, because of

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[27] Cf. G. Herries Davies, *Sheets of many colours: the mapping of Ireland's rocks 1750-1890* (Dublin: Royal Dublin Society, 1983); apparently in the late nineteenth-century the maps of the Geological Survey of Great Britain and Ireland were coloured by a Mrs. E. Williams of Camden, London (p. 229); however for Logan's use of Mr. [Charles R.] Bone, see Harrington, *Life of Logan*, pp. 370-1.

[28] "Geological Survey of Canada…", *Athenaeum* no. 2046 (12 January 1867): 49. In fact, this unsigned review noted that the sole feature of general interest was Logan's Laurentian formation, although really only for the purported existence of "*Eozoon*" fossils within it (see below, the second section of this chapter).

[29] On this issue, see von Bitter, "Logan's geological maps."

the problem of registration (each colour had to be printed separately, and getting all thirty properly lined up was virtually impossible), and of ensuring consistency between the map's two (western and eastern) sheets. As a result, this map was hand-coloured, many of the copies by Logan himself. Logan had not been fully satisfied with the applicability of British colours to Canadian formations: he was primarily concerned with the aesthetic appearance and practical legibility of the map. For example, "As the map was intended for candle-light effect, I put on a large part of the colour at night. Some that I had laid out by daylight I altered at night, in consequence of finding that tints which had been very distinct from one another could not be distinguished by candle-light."[30] Logan naturally thought of geologists, like himself, who would be busy with field or museum work during daylight hours, and who customarily saved their reading and writing work for the evenings and indeed nights. In this way, his own personal work habits actually shaped the Survey's published product.

An even more important difference between the large and small maps is in the amount of topographical detail included. In addition to incorporating all of the Survey's own observations, and much other unpublished data, Logan made use of virtually every published map he could obtain. There were at least thirty sources of data on Canada and the other British colonies, and a similar number on various American states. With twenty-five times more surface area than the Atlas index map, this large map was correspondingly more powerful in linking geological information to specific places. This, after all, was the fundamental project of a geological survey: not only to collect and describe resources, but to locate them at fixed points in space, so that others could find

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[30] Quoted in Harrington, *Life of Logan*, pp. 373-4.

and know them. As such, Logan's large general map of Canada and Eastern North America was the most powerful tool yet produced. From a governmental point of view, this single most salient difference between the 1865 index map and the 1869 general map can best be appreciated by looking at the example of a specific region; here, we take that of the Gaspé peninsula. Figure 2 shows the region as represented on the 1865 map, while figure 3 illustrates the same territory as published in 1869, dramatically more detailed. As figure 4 show, each geological feature is now attributable not to a roughly-defined region, but to a specific village, stream, or cove physically located on the ground, which Logan had visited. By adding topographical data to a geological map, one created knowledge: geological data, as Logan explained, was now grounded in specific places. The 1869 map also further intensified the degree of geological detail provided, raising to thirty-three the number of formations mapped (figure 5).

Finally, it is important not to overlook the fact that these two-dimensional maps, representing an idealized overhead view from space, were complemented by an additional technology of visual representation, in the case of especially interesting or complex structures: cross-sections running along a line across the landscape. These cross-sections were published in the 1865 Atlas, and thus use the same colour scheme. They represent an idealized slice through the terrain, depicting interpolated structures that are invisible from the surface. This is a very sophisticated form of geological mapping, and the technique of representing horizontal and vertical distances on the same scale had been pioneered by Logan in South Wales (see chapter 2). For example, in one section, a yellow band represented the Chic Choc mountains on the north coast of Gaspé, and a red dome depicts a granitic intrusion near the centre.[31] This combination of maps and cross-sections found in the 1865 *Atlas* provided mineral prospectors with the best available knowledge of both surface and sub-surface geology. More importantly, it also underwrote the message that geological maps held the secret to being able to see what lay underneath the earth's surface. In this way, they spoke directly to the desire and need for visual transparency, for a tool that could offer its users unlimited power to make reliable judgments about a place based its real, but invisible, inner nature.

To conclude the first half of this chapter, in considering the construction of the improved general map itself, we must now approach the question not from the perspective of the surveyor in the field, nor from that of eventual consumers of the map, but rather by looking over the shoulder of the Survey director in his office, simultaneously a consumer of surveyors' knowledge as it came in from the field, and a producer of knowledge as the one responsible for laying down definitive geological lines on the final map. The director, and founder of the Geological Surveyor of Canada, William Logan, was now in his mid-sixties; one of the most important young surveyors in the field, barely in his early twenties but destined eventually to explore more square miles of Canadian geology than anyone else before or since, was Robert Bell.[32] One of Bell's earliest assignments was to trace the boundary of the Niagara formation, which was important as the dividing line between two larger groups, the Middle and Upper Silurian (see chapter 5); Logan instructed Bell to find the location of the junction in as

[31] Section 10, Plate IV, GSC, *Atlas of maps and sections*. These very long, thin, finely detailed prints are unfortunately not suited for reproduction in the present format.
[32] On Bell's long, important, tumultuous, and ultimately unhappy career with the GSC, see Zaslow, *Reading the rocks*, chiefly part II.

many places as possible.[33] A few years later, in 1865, Bell was given the important task of revisiting Alexander Murray's earlier work on Manitoulin Island (the world's largest freshwater island).

Increased manpower on the survey, as well as better-understood geology, made it possible to improve on the efforts of the early days; Murray's examination of Manitoulin had been almost twenty years ago. However, there was an additional special reason for renewed interest in this island: from 1836 to 1862 it had been set aside as an experimental settlement for Native peoples from a variety of tribes, where is was hoped that they would be able to build a self-sufficient, self-sustaining society, free from the corruption of European influences. Manitoulin did have some arable land, and some Native families did practice farming, while others continued to hunt and fish, but the hoped-for mass migration of the remaining Indian population of Canada never materialized.[34] In 1862, most of the land was purchased from the Natives and surveyed for settlement by white farmers. In his report, Bell remarked that his general observations would be useful to prospective settlers, since so little was known about this island. Although the "Indians [had] fail[ed]" to take up agriculture and trades, Bell pointed out the abundance of invaluable materials suitable for local development, such as building stones, flagstones, whetstones, cement, quartzite for glass-making, gypsum, and petroleum.[35] The casual assumption that the Geological Survey was an instrument of white domination over

[33] W. E. Logan to R. Bell, 5 June 1861, BP/MUL. See also Bell to Logan (draft), 6 August 1861; 9 September 1861; 30 September 1861, Robert Bell Papers, Box 24, MG29B15, LAC.
[34] R. Surtees, "Treaty Research Report: Manitoulin Island Treaties," Treaties and Historical Affairs Research Centre, Indian and Northern Affairs Canada (Ottawa: Indian and Northern Affairs Canada, 1986).
[35] Geological Survey of Canada, *Report of Progress 1863-1866* (Ottawa, 1866), Bell report, pp. 169, 178-9.

Natives was expressed quite baldly, for example, in the pamphlet that had accompanied the Canadian exhibition at Paris ten years before: "in a new country like Canada, … the geologist was obliged to point out sources of mineral wealth hitherto unknown, preparing thus the way for the industry of civilized men who shall replace the savages."[36]

However pleased the interested public might have been with Bell's findings, though, Logan was not. He found Bell's surveying work distinctly lacking in the rigour needed if the new map was to be an improvement on the old one. Just because field knowledge did not appear on the final version, did not mean that it was acceptable to omit it from working copies:

> I have received the map; but I see no protracted lines upon it, as if worked from your field notes; and it therefore does not show me what your actual measurements are.… It is essentially necessary that every one employed on the survey should lodge in the office in an intelligent form their actual measurements in order that it may be shown how they established the position of the [~~strata~~] exposures of rock on which they have based their work, and in order to facilitate corrections at a future time, should the relation of their datum points be altered by reference to a more correct general map than those they depended on for their datum points at the time of their exploration.
>
> It appears to me you could not have made the map you have sent me without a protraction of some measurements, and it is these that I am

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[36] Hunt, *A sketch of the geology of Canada*, p. 415. The author of this introductory passage is unclear; it may have been editor T. S. Hunt or perhaps the Canadian exhibition commissioner J.-C. Taché, but was unlikely to have been Logan. On Taché, see DCB and B. Curtis, *The politics of population* (Toronto: University of Toronto Press, 2001).

> desirous of having and meant when I requested you to send me the map as it was. Have you protracted any of the measurements?[37]

Nevertheless, Logan needed the results of Bell's work quickly.[38] (At this point, the planned fix of the Paris 1855 map had now dragged on for more than a decade, and the large general map, although engraved, had still not been published.)

When the full-size version of the general map was finally distributed in 1869, marking the end of the Survey's first era, under Logan, it added a final element to the power of geological maps: thousands and thousands of place names. Environmental knowledge, science plus place, had already been linked to economic utility; now it was linked to human populations too. The map was the source of authority for the understanding that every village, hamlet, or still-uninhabited topographic feature lay on a specific geological formation, however invisible this might otherwise be, which held the key to its future agricultural or industrial development.[39] And this effect of transparency owed everything to the geologists who had meticulously determined boundaries in the field, deciding over and over where the demarcation between formations lay, so that these lines could become meaningful boundaries on the map.

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[37] Logan to Bell, 16 June 1866, BP/MUL. Logan suspected that Bell had actually sent him a pantograph copy, rather than his original map. Here we see that "action at a distance," however appealing as a model, actually required a high degree of centralized supervision in order to function; see Latour, *Science in action*, chap. 6.

[38] Logan to Bell, 15 December 1866, BP/MUL.

[39] It is at this point, with the creation of territory that could be analyzed and governed, that the GSC intersected most tightly with other projects of colonial state formation. See Curtis, *Politics of population*, on the census; and B. Braun, "Producing vertical territory: geology and governmentality in late Victorian Canada," *Ecumene* 7 (2000): 7-46, on the post-Confederation GSC in British Columbia. On the other hand, for corrective examples to such fantasies of perfect governance, see J. Scott, *Seeing like a state: how certain schemes to improve the human condition have failed* (New Haven, CT: Yale University Press, 1998).

The concepts of "borders" and "transparency" occur frequently in the science studies literature, often metaphorically.[40] However, in the cases of earth science, field science, and geographical science, these concepts have a literal meaning as well. A geological map really is about transparency; geological surveying is about the search for boundaries in the field. In order to achieve cartographic transparency, the surveying geologist has to seek out and follow borders in the field; the process of traversing these lines on the ground then becomes the foundation for the authority for drawing them on the map. Boundaries make transparency possible. As Murray's early topographic charts of northern rivers show, personal experience was key to the construction of knowledge in the field. But, equally, such traces had no place in the final maps, which depicted instead a completely idealized view in which all points within a formation had identical status, thus erasing the difference between where the surveyor had been and where he had not. Nevertheless, the sheer tenacity and heroism displayed by survey officers was invariably mentioned in both official and popular accounts, suggesting that the role of surveyors' personal field experience was not erased so much as given a new role. As the Toronto *Globe* put it, in assessing the *Geology of Canada*, "No one in any measure acquainted with the difficulties with which the survey has had to contend – difficulties arising from the impenetrable forests that still cover so large a portion of the country, the want of accurate topographical maps, the small number of men employed, and the comparatively small sum of money granted by the Legislature – can read this volume without being

[40] Examples include R. Kohler, *Landscapes and labscapes: exploring the lab-field border in biology* (Chicago: University of Chicago Press, 2002); T. Levitt, "Biot's paper and Arago's plates: photographic practice and the transparency of representation," *Isis* 94 (2003): 456-476.

astonished at the amount of work that has been performed, and the important results that have been attained."[41]

6.2 Before the Shield, the Laurentian

The Canadian shield did not exist in Logan's day, or even shortly after it; in fact, it did not come into being until the beginning of the twentieth century. In one sense, of course, this statement is silly: the rocks that we now call the Canadian shield have been there for literally billions of years. But in another sense, it is significant. After all, the Canadian shield is one of the most canonical icons of Canadian identity, so taken for granted that it is hard to imagine not being aware of it. To realize that there was a time when the shield was not recognized in its present form is to realize that it has a human history as well as a geological one. As a cultural object, it was brought into being at specific times, through recoverable processes, by identifiable people. In this final section, I am not only interested in the phrase "Canadian shield" itself, for it was not regularly used by geologists until about 1910, and did not enter popular discourse until the late 1920s. When it did become current, however, it was adopted quickly because it could be transplanted relatively smoothly onto existing notions, such as the "Laurentian plateau," which already referred to the same physical landform. So the real question is not so much how the Canadian shield got its name, as how it became identified as a natural unit, as something that needed a name; in other words, how it was created as a discursive object. To uncover this process, we have to go back to the 1850s and 60s, in those years after the good arable land in Canada West was settled out, and before Confederation

[41] Toronto *Globe*, 26 December 1863.

provided a western outlet for migrants seeking new farm land. These were the years in which Canadians bumped up repeatedly against the shield, attempted to live on it, and thus had many opportunities to think about what it was and how to understand it.

First, I look at how the Geological Survey laid the foundations for ideas about what would eventually become known as the Canadian shield, through its publications, museum and exhibition displays, and geological maps. Indeed, Logan's original creation of the terms "Laurentian" and "Huronian" to describe these rocks was seen even in his own time as one of his most enduring contributions. Second, I sketch out some of the prevailing public perceptions of pre-Confederation Canada's "northern" geology, as seen on the one hand in such sources as legislative committee reports and on the other hand in published travel narratives and other literature. Not surprisingly, I contend that a major, probably the single most important, source of ways to think about the north was the work being produced at the time by the Geological Survey of Canada. And finally, by way of epilogue, I examine the farther implications of Logan's work, and that of the Geological Survey he built, for thinking about the role of the shield, the north, and the environment generally, in Canadian history.

The nineteenth century was among other things a great age of "national" identity construction, both in Europe and its colonies around the world. Without making an argument for a proto-nationalist English Canadian identity in this very imperial-minded settler colony, in the nineteenth century, it is worth exploring the idea that the same institutional tools were employed in Canada to create geographical and geological self-awareness as were used elsewhere in the formation of ethnolinguistic nationalist movements. In Benedict Anderson's classic work on nationalism, *Imagined* *communities*, his chapter entitled "Census, map, museum," examines two things: "the role of the local colonial state, rather than the metropole, in styling [Third World] nationalisms," and the function of mapping in creating "changing apprehensions of space."[42] Taking his examples from southeast Asia, from the mid-nineteenth century onward, Anderson sees the typical colonial institutions of the census, the map, and the museum as having provided the raw materials for colonial (and eventually anti-colonial) self-definition and self-perception.[43]

What is useful to us in Anderson's analysis is that he has singled out exactly those institutions and practices that were so central to the work of the Geological Survey of Canada. If the survey was a kind of census of rocks and minerals (or, as Suzanne Zeller well phrased it, an inventory), it relied on categories of stratigraphic formations, also

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[42] B. Anderson, *Imagined communities: reflections on the origin and spread of nationalism*, revised edition (London: Verso, 1991), pp. xiii-xiv; this chapter was added for the revised edition. The literature on information-gathering and colonial state formation is very large; for influential Canadian studies, see A. Greer & I. Radforth, eds., *Colonial leviathan: state formation in mid-nineteenth-century Canada* (Toronto: University of Toronto Press, 1992), and Curtis, *Politics of population*. For Canadian national identity in the British imperial context, see P. Buckner, "Was there a 'British' empire? The *Oxford History of the British Empire* from a Canadian perspective," *Acadiensis* 32.1 (Fall 2002): 110-128.

[43] Anderson, *Imagined communities* p. 184. The map created national boundaries and the census created and enumerated "natural" categories of people living within this territory, while the museum did for time what the map did for space, imposing order on history in terms of "series" that legitimated the present regime. Although Anderson's principal concern is the impact of these institutions on nationalism *per se*, he points out that their practices reflect the colonial state's handling of knowledge of all kinds: "Interlinked with one another, then, the census, the map and the museum illuminate the late colonial state's style of thinking about its domain. The 'warp' of this thinking was a totalizing classificatory grid, which could be applied with endless flexibility to anything under the state's real or contemplated control: peoples, regions, religions, languages, products, monuments, and so forth. The effect of the grid was always to be able to say of anything that it was this, not that; it belonged here, not there. It was bounded, determinate, and therefore – in principle – countable. .... The 'weft' was what one could call serialization: the assumption that the world was made up of replicable plurals. The particular always stood as a provisional representative of a series, and was to be handled in this light."

known as "series," such as Silurian, Devonian, Laurentian, and Huronian. These were based on divisions of nature that were no less culturally mediated than the racial and ethnic categories used in the human census, as highly-publicized geological controversies in mid-nineteenth-century Britain demonstrated.[44]

The mechanically-reproduced products of the Geological Survey were its written reports and its printed maps (including some early examples of printing in colour, as discussed above). The Laurentian and Huronian figured prominently in both of these from the mid-1850s onward. Although Logan had first noted that Canada was fundamentally divided into an eastern, a western, and a northern division as early as his first reconnaissance of the province in 1842, and had prepared reports on the potential mining regions on the north shores of Lakes Huron and Superior later in the 1840s, the term "Laurentian" was not coined until 1853, following a project by assistant geologist Alexander Murray to trace the demarcation between the Silurian limestones and the older metamorphic rocks from Kingston to Lake Simcoe.[45] This expedition was an important exercise in boundary-making, as Murray made of series of north-south traverses as he worked his way westwards, crossing and re-crossing the Silurian-Laurentian division, demonstrating over and over the validity of Logan's categorization of Canada's rock into two "distinctly different" groups, diametrically opposed along a number of axes: "one set being fossiliferous and nearly undisturbed, and the other unfossiliferous and greatly

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[44] See Zeller, *Inventing Canada.* Debates over the demarcation between stratigraphic systems in nineteenth-century British geology have been very closely studied: see M. Rudwick, *The great Devonian controversy* (Chicago: University of Chicago Press, 1985); Secord, *Controversy in Victorian geology*; and D. Oldroyd, *The Highlands controversy* (Chicago: University of Chicago Press, 1990).
[45] RP 1843; RP 1846; GSC, "Report on the north shore of Lake Huron"; A. Murray, "Report of Alexander Murray," in RP 1852; Zaslow, *Reading the rocks*, pp. 52-4.

disturbed, contorted and altered."[46] Indeed, in this sense Murray did not so much trace the boundary as make it, definitively placing on the map the line that would forever after divide the future shield lands of the north from the flat limestone terrain of the south.

As described in the previous section, Murray then spent the next four years exploring the area between the Ottawa River and Lake Huron, the tract which was of so much interest to advocates of settlement and colonization roads, producing twenty large lithographed maps in an atlas of highly detailed (one inch to one mile) topographical maps with geological features.[47] These made the terrain of the Laurentian rocks visible as never before, fixing specific geological features to precisely-surveyed topographic features in the landscape. By 1856, even before his Huron topographic project had wound up, Murray was already making clear public statements, on the one hand about the distinctiveness of these northern lands, and on the other hand about their implications for Canada's future. At a dinner celebrating Logan's knighthood he told the assembled guests:

> During the last three years my duties have been those of a topographical engineer rather than those of a geologist, and I have consequently been obliged to visit, for the purpose of preparing maps, regions on the Northern shores of Lakes Huron and Superior, which were never seen before by a white man; and my maps will be found of great benefit in determining the course of immigration for the future settlement of the country. There is no doubt that there is a vast difference between that region and the peninsula [i.e., southern Ontario] placed between those

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[46] Murray, "Report," p. 47.
[47] GSC, *Plans*.

> western lakes, that is undeniable; but it is also true that there are vast and valuable tracts of land, and vast beds of valuable minerals there; and the time is coming when the land will be sought out and settled.[48]

This conceptualization, as exemplified here by Murray's personal comments, was further repeated and elaborated in the GSC's products and public representations throughout the 1850s and 60s, only becoming clearer and more detailed with each passing year.

When the Select Committee had evaluated the work of the Geological Survey in 1854, it had already been able to point to Logan's recently-described Laurentian system as probably being one of his most valuable discoveries.[49] Shortly thereafter, the Survey's display for the Paris Exposition of 1855 saw the inauguration of the Huronian system. In addition to the collection of rocks and minerals, arranged according to their industrial use, a large geological map was prepared, and Logan's chemist, T. S. Hunt, prepared a booklet, "Sketch of the Geology of Canada," that duplicated the physical inventory of geological specimens, including both a catalogue of the economic minerals and a discussion of the various formations found in Canada, beginning with oldest, the Laurentian, and continuing with one immediately above it, now described for the first

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[48] Murray concluded his remarks with, "And I would say, before sitting down, to sporting men, that those who are fond of sport would do well to resort to Lake Nipissing, for there they will find deer and bears, and all sorts of good fun." The occasion was the elaborate dinner held for Logan in Toronto on 5 April 1856. Hand-corrected clipping, undated [April 1856], Toronto *Globe*, W. Logan, "Scrapbook," TPL.

[49] J. Langton, "Report of the Select Committee appointed to report upon the best means of making public the valuable information already obtained by the Geological Survey, and completing it at an early stage upon an uniform system," Appendix L, JLA 1854-5. The Committee (see chapter 5), chaired by future Board of Audit chairman John Langton, included a mix of state officials and private individuals; such quasi-official bodies were clearly important agents in producing the complex of institutions identified by Anderson.

time: the Huronian.[50] Hunt's description made it clear from the outset that Canada was fundamentally divided into north and south by the Laurentian mountains, from which the geological system took its name. Visitors to the exhibition could thus read the description (census, inventory) of Canada's geology, see the formations coloured in huge swathes on the map, and examine physical specimens of the actual rocks that those colours represented.

Through the later 1850s and early 1860s, Logan continued to use public occasions to elaborate his vision of Canada's Laurentian and Huronian lands. At the meeting of the American Association for the Advancement of Science, held for the first time outside the U.S. at Montreal in 1857, he read papers that established the scientific basis for the distinction between the two types of formations, and examined the possibility of making subdivisions within them.[51] This meeting coincided with the opening of the Survey's revamped museum, with the first floor devoted to economic materials and rock specimens from the older formations. The upper two floors contained fossils from the limestone strata that made up southern Canada, but the association of the non-fossil-bearing Laurentian and Huronian rocks with the economically valuable ores and minerals that greeted the visitor helped reinforce the idea that the northern part of the province was

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[50] Hunt, *A sketch of the geology of Canada*, pp. 427-8.

[51] W. E. Logan, "On the division of the Azoic rocks of Canada into Huronian and Laurentian," *Canadian Journal of Industry, Science and Art*, new series 2 (1857): 439-442; "On the probable subdivision of the Laurentian rocks of Canada," *Canadian Journal of Industry, Science and Art*, new series 3 (1858): 1-5. Many, including Logan himself, saw his description of the Laurentian as his most original and significant contribution to global geology. The point is that Logan was claiming that recognizable stratigraphic systems existed in the previously indivisible "primary" granitic rocks that underlay the oldest known stratigraphic systems; the Huronian and the Laurentian were groups that could be identified and distinguished repeatedly (just as groups like the Silurian and the Devonian were), even though these older rocks did not contain fossils, upon which stratigraphic identifications were usually made.

the richer.[52] At the 1862 London International Exhibition, a separate series of specimens from crystalline rocks was added to the traditional arrangement of economic minerals, thus providing a place for the Laurentian and Huronian to be singled out for particular attention.[53]

In short, anyone who wanted to contradict Logan's image of Canadian geology would have been overwhelmed by the massive support it had already earned, both in terms of material evidence and in terms of personal allegiances. Thus, when Count E. S. De Rottermund reappeared on the scene in 1856 as a mines inspector in the Crown Lands Department, arguing that the Laurentian and Huronian were actually Tertiary-age formations (i.e., much younger than those anywhere else in Canada), and that coal lay beneath them, he encountered an unflinching scientific consensus, a fact which Logan's friend W. B. Robinson urged him to make better known:

> You should get [New York geologist James] Hall & other savans [i.e., scientists] to show up the Report of the Count & point out how injurious it is for <u>non savans</u> to gravely state as facts important matters relating to our country which at a distance where neither the Count or the country are known may do harm. I know your reply: "Why every one knows the man is an ass." No every one does not know it. [Crown Lands commissioner Joseph-Édouard] Cauchon does not, & the question is can either you or Hall or [Harvard University zoologist Louis] Agassiz enlighten him. If

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[52] E. Billings, "Report for the year 1856," in RP 1853-54-55-56, pp. 138-197.
[53] Geological Survey of Canada, *Descriptive catalogue of a collection of the economic minerals of Canada, and of its crystalline rocks, sent to the London International Exhibition* (Montreal, 1862). Metamorphic rocks from the Silurian and intrusive (volcanic or magmatic) rocks were also listed under their own headings.

not ask [GSC chemist T. S.] Hunt if he can analyze & classify the animal.[54]

Indeed, Logan turned his attention next to the highly-visible products that would make the Laurentian and the Huronian as deeply entrenched among the interested public as they already were among geologists.

In the remainder of the 1860s, Logan's last years as Director of the Geological Survey, the final products of his programme, the grand synthetic works, arrived: in 1863, the 983-page *Geology of Canada*; in 1865, its accompanying *Atlas*, which included maps specifically dedicated to delineating Huronian and Laurentian areas; and in 1869, the long-awaited, large-scale, wall-sized, full-colour geological map of Canada.[55] All of these reinforced the idea that Canada's north was a discrete geological entity, stretching over a vast and still incompletely-explored expanse. It held Canada's richest deposits of economic minerals, and mineral extraction represented its best hope for development.

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[54] W. Robinson to Logan, 25 September 1856, LP/MUA. Cf. also chapter 5 above.
[55] See chapter 5 above; the regional maps, numbered II (Laurentian) and III (Huronian) in the *Atlas* were much more detailed than even the large 1869 general map, at seven and eight miles to the inch respectively, with the geological formations divided into several lithological sub-units. Map II covered "the counties of Ottawa, Terrebonne, Argenteuil, and Two-Mountains [i.e., the southern part of the Laurentides, north of the Ottawa River]," while map III depicted the region north of Lake Huron, "between the rivers Bachewahnung [Batchawana, at the eastern end of Lake Superior] and Mississagui [Mississagi]." GSC, *Atlas of maps and sections*, text pp. 20-21.

Also in this period, Logan was among the participants in a scientific debate over an alleged Laurentian fossil called *Eozoon canadense*. This would have been by far the earliest known form of life, but critics dismissed it as a mineralogical phenomenon. The debate attracted wide attention among geologists and biologists, thus helping bring the Laurentian system to a large scientific audience, but it played only a minor role in shaping Canadians' perceptions of the north, which, suffice to say, were driven by economic rather than scientific interests. See C. O'Brien, "*Eozoön canadense*: 'the dawn animal of Canada'," *Isis* 61 (1970): 206-223. The most vocal and lasting of the proponents of *Eozoon* was Logan's Montreal colleague J. W. Dawson; see the discussion of this controversy in S. Sheets-Pyenson, *John William Dawson* (Montreal & Kingston: McGill-Queen's University Press, 1996).

Logan had given this area firm southern boundaries, based on years of geological mapping; he had created scientific categories in which to enumerate its rocks; and he had arranged specimens of these ("replicable plurals" as "representative of a series," in Anderson's terms) in exhibitions and museums to display their economic value. In short, through his survey, map, and museum, Logan had constructed the Laurentian and the Huronian as a new basis for thinking about Canada's north, shortly to become a burning topic with the advent of Confederation and the turning of hungry southern eyes towards the vast expanses of Rupert's Land.

Recall that much of southern and southwestern Ontario is based on limestone: these were the flat, fertile lands opened up for British settlement after 1791. But north of these, not very far north at all, in some places, lie crystalline granites and gneisses that produce rocky, swampy terrain with limited agricultural potential. Some of the first settlers to encounter these lands were in eastern Ontario, immediately north of Kingston, where what we now call the Canadian shield comes down to the shore of the St. Lawrence. Land in this area was distributed, and even settled to a limited extent, as early as the 1820s and 30s.[56] However, the peak of settlement activity in these marginal areas, essentially stretching westward from the upper Ottawa River to the eastern shore of Georgian Bay, began in the mid-1850s, and began to decline soon after, in the mid-1860s. The main source of support for settlement was the building of colonization roads to provide access to the interior, but these could not compete with either the difficulty of extracting a living from this challenging environment, or the lure of new lands farther

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[56] B. S. Osborne, "Frontier settlement in eastern Ontario in the nineteenth century: a study in changing perceptions of land and opportunity," in D. Miller and J. Steffen, eds., *The frontier: comparative studies* (Norman, OK: University of Oklahoma Press, 1977), 201-225.

west.[57] As early as 1858, Logan's "valuable maps, sections, and other details" were cited as contributing to the "basis for a reliable report" on the related question of establishing a navigable water route between the Ottawa River and Lake Huron.[58] An examination of several investigations commissioned by the Legislative Assembly in the mid-1860s indicates the state of public thinking on the uses to which the lands north of settled areas could be put, and how they could be developed.[59]

One of the most important reports in this respect was that of the 1864 Select Committee on the Ottawa and Georgian Bay territory, charged with investigating "the natural features, adaptation for settlement, resources and extent of the territory ... and also ... the best means of opening up and developing the said territory."[60] These mostly unsurveyed expanses contained "the only large body of good lands of any extent now belonging to the Crown," which was important because "unless settlement can be carried on in this region, Canada would remain a mere frontier strip bordering the margin of the St. Lawrence and the Great Lakes." The Committee divided the lands under

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[57] H. Parson, "The colonization of the southern Canadian Shield in Ontario: the Hastings Road," *Ontario History* 79 (1987): 263-273; G. Wall, "Pioneer settlement in Muskoka," *Agricultural History* 44 (1970): 393-400; and G. Wall, "Nineteenth-century land use and settlement on the Canadian Shield frontier," in Miller & Steffen, *Frontier*, 227-241. A conflicted relationship with the logging community, and overly optimistic evaluations by land surveyors, were two other problems that many found difficult to surmount. For background on the Quebec case, see R. C. Harris and J. Warkentin, *Canada before Confederation: a study in historical geography* (New York: Oxford University Press, 1974), pp. 87-93. See also the *Public Lands Act*, 1853; *Free Grants and Homestead Act*, 1868; *Forest Reserves Act*, 1899. For an environmental history approach, see N. Forkey, *Shaping the Upper Canadian frontier* (Calgary: University of Calgary Press, 2003).
[58] C. Alleyn and H. Killaly, "General report of the Commissioners of Public Works," Appendix 19, JLA 1858, p. 42.
[59] For a theorized analysis from a governmental perspective, see J. Walsh, "Landscapes of longing: colonization and the problem of state formation in Canada West," Ph.D. thesis, University of Guelph, 2001; particularly on the science of land surveying, chap 3.
[60] "Report of Committee on Ottawa and Georgian Bay Territory," Appendix 8, JLA 1864. The committee was chaired by Alexander Morris.

consideration into what they called "two great natural and geographical sections," north and south of a line formed by the "Mattawan" and French Rivers and Lake Nipissing. In discussing first the southern area (the Ottawa-Huron Tract), about a third of which had already been surveyed under the colonization roads program of the previous decade, the Committee began with a simple statement: "The geological structure of the Territory is 'Laurentian'." After explaining that this term implied not only gneiss and great masses of feldspars, but also the existence of "important bands of chrystalline [sic] limestone," their report continued: "A popular impression has prevailed that the country was of purely granite formation and therefore sterile, but this is erroneous. Sir William Logan is of opinion that fertile land will be found not alone where the limestone bands crop out, but also over a surface more or less extended, wherever the ruins or *débris* of the limestone have been deposited in the valleys."

In Logan's response to the Committee's questions, he quoted from one his earlier Reports at length, providing a detailed explanation as to why Laurentian rocks, though largely granitic, also contained other minerals and did not necessarily imply infertile soil.[61] Indeed, Logan estimated that between a sixth and a quarter of the Ottawa-Huron Tract would be underlain by rocks containing lime, and thus be potentially fertile. He also explained that the other area of interest to the Committee, the unsurveyed lands north of Lake Huron, were partly Laurentian and partly of a different geological formation, the Huronian. Limestone was much rarer in this territory, but it did hold other minerals that might form a decent soil. When asked for his conclusions about its suitability for

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[61] "Report of Committee on Ottawa and Georgian Bay Territory," Appendix: Questions Submitted. Sir W. Logan, Answer to Question 16. The original Geological Survey Report of Progress is RP 1853-54-55-56.

settlement, Logan phrased his advice in geological terms: "It appears to me of the highest national importance that the available parts of the Laurentian region generally should be settled upon, as the Devonian and Silurian rocks hitherto chiefly resorted to constitute little more than an extended narrow strip along the frontier of the country."[62] Of the eighteen pages of evidence gathered by the committee, three came from Logan alone, while two further pages of testimony by surveyor S. J. Dawson quoted repeatedly from the Geological Survey's massive summary volume, the *Geology of Canada*, which had been published just the year before.[63] Logan's assessments of the terrain led off the Committee's verdict on each of the two territories it studied, but his comments also indicated that these northern lands were better considered as related geological formations, rather than as divided by arbitrary surveying lines based on their distance from settled areas.

While the principal concerns of the initial inhabitants of the Laurentian areas had been agriculture and timber extraction, by the 1860s there was growing interest in the mining and mineral potential of these lands, fostered again by the Geological Survey's ongoing reports. One of the most actively-pursued colonization programmes in eastern Canada West, where the granitic rocks extended almost as far south as Lake Ontario, was in Hastings County, which boasted a relatively well-developed colonization road that had been overseen by an enthusiastic agent, M. P. Hayes, who had been an important witness

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[62] "Report of Committee on Ottawa and Georgian Bay Territory," Logan, Answer to Question 17. The Devonian and Silurian are the limestone formations of southern and southwestern Ontario, which contained almost all the arable land in the province. Logan was presumably reflecting concerns about Canada being over-concentrated along the U.S. border, especially as the Civil War was in progress and British North Americans were worried about a possible invasion.

[63] Geological Survey of Canada, *Report of Progress from its commencement to 1863* (Montreal: Dawson, 1863); see chapter 5. On Simon Dawson, see DCB.

before the 1864 Committee on the Ottawa and Huron lands.[64] In 1865, residents of Hastings County petitioned the Legislative Assembly for a grant of 500,000 acres of unsettled land to help them build a railroad "with a view of carrying on mining operations in the northern Townships of Hastings." The legislature naturally turned to its Geological Survey to answer this question, asking what Logan already knew of the "mineral character" of the region, and whether an additional special exploration would be warranted. In reply, Logan pointed out that "the economic minerals of the district" were "almost wholly confined" to the Laurentian series of rocks in the county, so these would be the only ones worthy of further study.[65] To date, this area had only been studied in a general way, as part of Murray's project to map the demarcation line between the Silurian (limestone) and Laurentian strata across the province. Essentially, Logan told the government, and the people of Hastings County, that to the extent their lands contained valuable minerals, it was because their rocks, located no farther north than Ottawa or Montreal, were in fact part of a larger continuous Laurentian formation that stretched as far away to the north, northwest, and northeast as had ever been explored.

In 1866, another Select Committee was appointed, this time to evaluate the northern mining lands specifically. Although their official brief covered only the copper mines on the north shore of Lake Superior, they soon realized that it would be "expedient to extend their enquiry to the north side of Lake Huron as well as Superior, and to procure as much information as possible respecting iron and other economic minerals, as

[64] See Parson, "Colonization."

[65] W. E. Logan to W. McDougall, 24 December 1865, in "Return ... on the subject of the Mines and Minerals in the Townships, and in rear of the County of Hastings," Sessional Paper 25, JLA 1866.

well as copper."[66] This was because the witnesses who appeared before the Committee generally had knowledge of the region as a whole. Three of the seven witnesses were directly connected to the Geological Survey: Logan and two of his explorers, Thomas MacFarlane and Robert Bell; while two others specifically referred to Sir William's work.[67] Everyone agreed that the area was rich in many minerals and would support prosperous mines, although they differed on how soon. For his part, Logan reaffirmed his 1846 findings and asserted that "copper exists in sufficient quantity to become gradually, as the country advances, the means of giving support to the industry of a mining population."[68] Here his focus was clearly on the future, and on the question of the basis for human settlement.

The geologists' assessments of the agricultural potential of these lands, however, in response to another of the Committee's questions, were more balanced than some previously. Rather than endorse hopelessly optimistic visions of widespread pastoral settlement, they pointed out that the good lands were distinctly in the minority. MacFarlane said that the Laurentian and Huronian formations made for hilly, rocky country, with "very little agricultural land of value," and although Logan still maintained

[66] *Report of the select committee on the copper mines on the north side of Lake Superior* (Ottawa: Hunter, Rose & Co., 1866). The committee chairman was Francis Jones.
[67] Thomas A. Begley (or Begly), Explorer, testimony, *Report ... on the copper mines*, p. 19; and Thomas Devine, Crown Lands Department, testimony, *Report... on the copper mines*, p. 24.
[68] W. Logan testimony, *Report ... on the copper mines*, p. 12. He omitted, however, a more speculative statement about iron ore deposits, as found in his draft version of his responses: "though the quantity of rich ore is not so great in these parts as it is at [blank] yet as the ore is subordinate to the stratification, it is not unreasonable to expect that such variations in the conditions of deposit will occur as to lead to greater results in some part of the distribution of the series." W. Logan, "Questions submitted to Sir William Logan," box 1, Logan manuscripts, ESIC. Compare the printed version (question 5, p. 13); such restraint undermines the credibility of any suggestion that Logan put promotion over science.

that the Huronian rocks north of their namesake lake could support settlement, he admitted that the Laurentian series that lined the Canadian shores of Lake Superior were "of inferior Agricultural capabilities." Bell, who in fact had the most field experience in this area, agreed with his colleagues that the Huronian rocks were "generally productive of useful minerals," but dismissed them agriculturally as "generally unpromising, being mountainous and rocky."[69] It was increasingly clear that the entire vast expanse of Canada north of Lakes Huron and Superior was a natural region which, despite its internal variety, was sharply distinguished from the south by its geology, and whose economic future lay in mineral extraction, not in the traditional farming pursuits that had so successfully filled up the lower parts of the province in the early days of settlement.

So, if the Canadian north was described to official audiences by the Geological Survey in terms of its Laurentian and Huronian formations, it remains to be seen how this image was taken up by other writers and given a life of its own. For our purposes, a few selective examples may suffice, the earliest of which is Henry Youle Hind's well-known narrative of the Assiniboine and Saskatchewan expedition of 1858, the sequel to a trip to the Red River the previous year. Hind, himself a geologist and a personal acquaintance of Logan, took up the terms Laurentian and Huronian within a few years of their original publication, discussing them in detail in conjunction with his account of the voyage west to Lake Winnipeg, and claiming that: "The crystalline limestones in the Laurentian series are daily acquiring increased importance."[70] Hind cited British geological reports to

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[69] T. MacFarlane testimony, *Report ... on the copper mines*, pp. 9-10; W. E. Logan testimony, *Report ... on the copper mines*, p. 12; R. Bell testimony, *Report ... on the copper mines*, p. 15.

[70] H. Y. Hind, *Narrative of the Canadian Red River exploring expedition of 1857 and of the Assinniboine and Saskatchewan exploring expedition of 1858*, vol. II (London, 1860),

show that the Logan's Laurentian system was even being adopted in the mother country, and he indicated that the long expanses of ancient granites and gneisses making up the northern part of the colonial province of Canada, which the Geological Survey had brought together under the twin headings of Laurentian and Huronian, also extended far into Rupert's Land.[71]

In the immediate post-Confederation environment, the idea that such rocks could be an inducement, rather than an obstacle, to development was quickly applied to Laurentian and Huronian formations wherever they were found. For example, in George M. Grant's classic 1873 account of his cross-country expedition with railroad surveyor Sandford Fleming, *Ocean to Ocean*, he concluded:

> We are satisfied that the rugged and hitherto unknown country extending from the upper Ottawa to the Red River of the north, is not, as it has always been represented on maps executed by our neighbours, and copied by ourselves, impracticable for a Railway; but entirely the reverse; that those vast regions of Laurentian and Huronian rocks once pronounced worthless, are rich in minerals beyond conception, rich in gold, silver, copper, iron, tin, phosphates of lime, and -- strange as the assertion may

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pp. 269-82; see p. 274. See also Zaslow, *Reading the rocks*, pp. 78, 106-7; and more generally W. Morton, *Henry Youle Hind* (Toronto: University of Toronto Press, 1980). On Logan's role in securing this commission for Hind, see Logan to H. Y. Hind (draft), 7 July 1857, LP/MUA, and Hind's replies to Logan in the same folder. James Hector of the Palliser expedition did similar important work, but it was not published until 1863; this is not to say that all writers interpreted the northern environment in Logan's terms, but merely to illustrate the function played by the Laurentian for those who did refer to it.

[71] Even popular accounts that did not use this specific nomenclature still firmly expressed the idea that Canada was divided into geologically distinct northern and southern parts. See, for example, "Canadian Minerals," in C. P. Traill, ed., *The Canadian settler's guide* (London, 1860), p. 114.

> appear -- probably coal; that in the iron back-ground to the basin of the St. Lawrence, hitherto considered valuable only for its lumber, great centres of mining and manufacturing industry, shall in the near future, spring into existence; and that for the development of all this wealth, only the construction of a Railway is necessary.[72]

For Grant, geology was inextricably implicated in his central agenda, the construction of a transcontinental railroad. It was the results of the Geological Survey, its mandate now extended to cover the whole Dominion, that made his argument possible.[73]

By 1889, these geological descriptions had also been thoroughly assimilated into the prevailing aesthetic view of the north, as this example from William Withrow's *Our Own Country; Canada, Scenic and Descriptive* shows:

> The natural features of our great northern lakes, Huron and Superior, are on a vaster scale than in the smaller lakes. The shores are much bolder and of a sterner character. The scenery is more sublime, but less beautiful. .... The entire north coast of Lake Huron is indented with a thousand inlets, separated by rocky capes. The La Cloche Mountains, rising two thousand feet above the sea, stretch along its entire length. They are, for

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[72] G. Grant, *Ocean to ocean: Sandford Fleming's expedition through Canada in 1872* (Toronto, 1873), pp. 352-3. His reference to coal may have been meant to apply to the area just east of the Rockies. George M. Grant (DCB) is also remembered for his significant role as Principal of Queen's University.

[73] For Canadian attitudes to northern mineral resources after Confederation, see the important study by Morris Zaslow, *The opening of the Canadian north 1870-1914* (Toronto: McClelland and Stewart, 1971). Zaslow is one of the few historians to give a significant role to the Geological Survey in nineteenth-century developments; it is not coincidental that he also wrote the officially-commissioned history of the GSC. For a more narrowly-focused study, emphasizing other factors, see H. V. Nelles, *The politics of development: forests, mines and hydro-electric power in Ontario, 1849-1941* (Toronto: Macmillan, 1974), especially pp. 20-31.

> the most part, gray, barren rocks of the Huronian formation, with highly tilted strata, and without timber enough to carry a fire over them. They stretch, like a billowy sea, wave beyond wave, as far as the eye can reach – a scene of stern and savage grandeur, almost appalling in its desolation.[74]

This response to the north contains recognizably modern aesthetic elements with regard to the Canadian wilderness.[75] Any attempt to see the land as potentially fertile, as even Logan had claimed the north shore of Lake Huron might be, had now been completely eliminated. Instead, the rocks were celebrated for their intrinsic qualities, with the confidence that these gave them their value. Of course, Withrow, like Grant, had his own agenda (in this case, partly moral); both were firm believers that their new country's conjunction of climate, geography, and British heritage gave it almost limitless potential for greatness.[76] These were not beliefs they got from geology or geologists; rather, geological concepts gave them a vocabulary and a grammar with which to articulate their convictions. Thanks to the Geological Survey's effective elaboration of the categories Laurentian and Huronian, these ideas, ostensibly just used to describe rocks, had become discursive objects that writers like Grant and Withrow could simply invoke.

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[74] W. H. Withrow, *Our own country Canada: scenic and descriptive* (Toronto, 1889), p. 382. Withrow (1839-1908) was a Methodist writer and editor, and Fellow of the English-language historical section of the Royal Society of Canada. See C. Berger, *Honour and the search for influence: a history of the Royal Society of Canada* (Toronto: University of Toronto Press, 1996), p. 36.
[75] A major study of this topic is S. Grace, *Canada and the idea of north* (Montreal/ Kingston: McGill-Queen's University Press, 2001); discussed in more detail below.
[76] The classic work in this field is C. Berger, *The sense of power: studies in the ideas of Canadian imperialism 1867-1914* (Toronto: University of Toronto Press, 1970).

All this had come to pass even before the idea of the Canadian shield made its first appearance. Today, the use of the term Laurentian in this stratigraphic sense is itself only a fossil, although it has survived in other senses, such as the "Laurentian shield." It would be the scientists not one but two generations after Logan who would be responsible for transforming the fruits of his early characterizations, into a concept that quickly became the most self-evident and important feature of Canadian geography. Thus, as it happened, the new term "Canadian shield" was not adopted until after 1905, after a quarter-century of heated debate between American and Canadian scientists over the internal structure of what Logan had called Laurentian and Huronian areas ended in stalemate. Intermediate names included the less euphonious "Great Northern Nucleal Area of Archean Rocks."[77] Later generations of geologists had found the area much more complex than Logan's simple description could account for, but they acknowledged that his "first broad classification of the pre-fossiliferous rocks into the Laurentian ... and the Huronian ... was not improved upon for a long time."[78] The term "Canadian shield" itself was a literal translation of the German, "*der canadische Schild*," which was first

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[77] F. D. Adams, "Problems of the Canadian shield -- the Archaeozoic," in *Problems of American geology* (New Haven: Yale University Press, 1915): 43-80, p. 45. For a representative view of the evolution of ideas about this region, in the standard American textbook of geology, compare J. D. Dana, *Manual of geology* (Philadelphia, second edition, 1864), p. 137, with Dana, *Manual* (New York, fourth edition, 1894), pp. 442-446. On the debate, see W. Eagan, "'Is there a Huronian group?': the debate over the Canadian Shield, 1880-1905," *Isis* 80 (1989): 232-253. Strangely, however, Eagan refers to the shield unproblematically throughout his analysis without once mentioning that it was a term settled upon only after the debate was over – an instance of the historiographical problem I discuss below.

[78] A. P. Coleman, "The Proterozoic of the Canadian Shield and its problems," in *Problems of American geology*, 81-161, p. 82.

used by the Austrian geologist Eduard Suess in his highly influential late nineteenth-century synthesis of geological science.[79]

Canadian Survey geologists, most notably Frank Dawson Adams, were exposed to this concept when they undertook graduate study in Germany in the 1890s.[80] However, the phrase did not become well-established in English until a translation by Hertha Sollas (daughter of the Cambridge geologist W. J. Sollas) appeared in 1906.[81] By 1921, however, the term was sufficiently commonplace for a textbook to simply announce that "the first and most remarkable" feature of Canadian geology was "the existence of an enormous outcrop of ancient crystalline rocks surrounding Hudson Bay in a U-shaped manner, and frequently termed the '*Canadian protaxis*' or '*shield*'."[82] All of this is merely to demonstrate that while knowledge of the shield, like the shield itself, has a lengthy and convoluted history, the actual label, "the Canadian shield," does not. To settlers and legislators in the 1850s, interested in agriculture and lumbering, it was certainly not self-evident that their province would naturally and inevitably come to be

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[79] E. Suess, *Das Antlitz der Erde*, 3 vols. (1883-1909), see vol. 2 (Vienna, 1888), p. 42. On Suess, one of the most important geologists of his day, see M. T. Greene, *Geology in the nineteenth century* (Ithaca, NY: Cornell University Press, 1982). The fact that it was Suess who named the shield is noted in J. McPhee, *Annals of the former world* (New York: Farrar, Straus and Giroux, 1998).

[80] F. D. Adams, "Ueber das Norian oder Ober-Laurentian von Canada," Ph. D. thesis, University of Heidelberg, 1893. Printed in *Neues Jahrbuch für Mineralogie* 8 (1893): 419-98; available on CIHM microfiche 01473. For a review, and the first English-language appearance of "Canadian shield" that I found, see A. C. Lawson, "The Norian rocks of Canada," *Science* 21, no. 538 (26 May 1893): 281-282. (On Lawson's other activities, as a promoter of Logan's memory and of geological masculinity alike, see chapter 4).

[81] H. B. C. Sollas, *The face of the Earth*, vol. 2 (Oxford: Clarendon Press, 1906), p. 30. Hertha Sollas was herself a Heidelberg Ph.D. and associated with Newnham College, Cambridge; biographical information about her is scarce. The translation (5 vols., 1904-1924) was reviewed by a team of eminent geologists, with W. J. Sollas serving as general editor.

[82] F. Reed, *The geology of the British Empire* (London, 1921), p. 198.

seen in such terms.[83] In fact, it was Logan's work (and by extension, that of his successors) that was fundamental in defining future assumptions about Canadian geography. The story is not complete, however, until we see how the idea of the shield entered popular consciousness, and flourished, in the 1920s. At the heart of this process is an interesting question about the role of the environment in historical writing, which I now turn to in concluding this chapter.

The Canadian shield has been referred to, and used as an explanatory device, by many historians, including, most notably, the geographically-oriented generation that began with Harold Innis and Arthur Lower and continued with Donald Creighton and William Morton.[84] Thus Creighton, for example, in *Dominion of the North* referred repeatedly to the Precambrian shield (an alternate name) as an active agent in the nation's history, imagining that Cartier perceived it instantly and accurately even in 1535.[85] And yet rarely, if ever, is it acknowledged that the modern popular understanding of the shield itself, as a natural and obvious object, is a relatively recent phenomenon. In criticizing the tendency of older writers like Creighton to inappropriately conflate the Canadian north and the Canadian shield (given that ample parts of the shield in Ontario and Quebec lie south of the southern border of western Canada), Sherrill Grace gives scarcely any

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[83] However, cf. Walsh, "Landscapes of longing," p. 112, for an example of the all-pervasive assumption that "the Canadian Shield" was an entity that Logan engaged with.
[84] C. Berger, *The writing of Canadian history* (Toronto: University of Toronto Press, 2nd edition, 1986). See, e.g., A. Lower, "The assault on the Laurentian barrier, 1850-1870," *Canadian Historical Review* 10 (1929): 294-307, and W. Morton, *The Canadian identity* (Toronto: University of Toronto Press, 1961).
[85] D. Creighton, *Dominion of the north: a history of Canada*, 2nd edition (Toronto: Macmillan, 1957), see pp. 5-6.

attention to the shield in her more recent analysis, despite the fact that it did constitute the "north" in the days of the pre-Confederation province of Canada.[86]

What needs to be understood about Creighton's view of the shield is that it is itself historically grounded in the 1920s and afterwards, when the economic potential of Logan's Laurentian and Huronian rocks finally began to be realized, and when the term "Shield" first came into widespread popular use.[87] Thus, from Creighton's description of the interwar economic boom, it is evident that he also equated the shield of the early twentieth century with the poorly-known lands of fur and timber to which Logan had brought order in the mid-nineteenth:

> The Shield, the enormous irregular triangle of rocky, ravaged upland, had been both a barrier to economic progress and a bulwark of economic development. These ancient, worn-down rocks, with their vast stretches of towering conifers, their elaborate mazes of lakes, lakelets, rivers, falls, rapids, and spillways, had been the basis of both the fur trade and the timber trade.... Men had exploited its animals and forests; but now they were to tear out wealth and power from its soils, and rocks, and waters.[88]

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[86] Grace, *Canada and the idea of north,* pp. 60-61.

[87] For early mentions of the Geological Survey of Canada's work on the "Canadian Shield," and the ore deposits newly found there, see "Ontario reports rich gold strike," *New York Times*, 10 June 1928, p. 43; and "Canadian minerals sought by planes," *NYT*, 11 May 1930, p. 42. For the explosion of the mining industry in this period, see also Nelles, *The politics of development.*

[88] Creighton, *Dominion*, pp. 472-4. A basic problem is that the shield really does lie both very far north and very far south; this may suggest that it is not so natural and desirable a unit of analysis as it has seemed. For the recent genealogy of historical interest in the far north, see the insightful article by J. Cavell, "The second frontier: the north in English-Canadian historical writing," *Canadian Historical Review* 83 (2002): 364-389. Indeed, Cavell asserts that the nineteenth-century "north" was the area just north of agricultural zones, as well as Rupert's Land, something much closer to Logan's Laurentian territory.

We see a double conflation here: the shield of the present becomes the shield of the past, and the north of the past becomes the north of the present. The formation of the Canadian shield as a discursive object, a process begun in Logan's day, was not completed until Creighton's (or even then); in turn, this object called the Canadian shield, constructed through historical and cultural processes, has been read back onto its own past. An awareness of such issues is one of the contributions the history of science ought to be able to make to environmental history and historical geography. Landforms themselves, even multi-billion-year-old rocks, are cultural objects insofar as they are perceived and responded to by humans, and as such they can have recent and twisting histories.[89]

Thus, the story naturally divides itself into three periods. Up to 1850, as Logan's survey was only just beginning to take effect, we can fairly say that the Canadian shield did not yet exist. The land it was to occupy, for example the Ottawa-Huron Tract, was known only through elementary land surveying, if at all, and was thought of in terms of agricultural crop production. By 1870, however, the basic elements of the shield had been produced in the form of the Geological Survey's Laurentian and Huronian systems, which were published and disseminated, printed and coloured on maps, and displayed in museums and exhibitions in Canada and abroad. This understanding of the land, which made its way into government reports and literary accounts, emphasized the enormous size and unbroken consistency of the territory covered by these northern rocks, thus supporting that enduring duality of the shield as a place of both great wealth (mineral)

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[89] Osborne, "Frontier settlement," notes that the environment was not an objective element in the development process, but that the interpretation of its capabilities varied, and this had an important effect on what people chose to do; p. 221.

and terrible poverty (agricultural). And finally, by 1930, the Canadian shield (known less nationalistically as Precambrian, or occasionally even still Laurentian) was at last economically productive, and taken to heart by Canadians, who promptly began to view their own past through the new focus it provided.[90] In this way did Logan's pioneering identification of the Laurentian become one his most important legacies.

One of my goals has been to draw connections between "bottom-up" view of geology as it was practiced by Logan and his colleagues, and the "top-down" story of Canadian social and economic development. It has often been asserted, and assumed, that the Geological Survey played an important role in this era of Canadian history, but it has also been hard to give specific examples.[91] This is largely because the enormous economic impact due to the growth of mineral resource extraction industries was not felt until well into the twentieth century: in Logan's day, notwithstanding the occasional minor gold rush, the importance of geology in the Canadas was primarily local, limited to small-scale iron ore smelting, lime burning, and quarrying for building materials. However, I would argue that the most significant work of the Survey was simply to gather, process, and publish data in textual, visual, and material form. As Benedict Anderson argued, once the surveys are published, the maps drawn, and the specimens placed in museum displays, they can go on to serve new purposes as a rallying-point for developing national consciousness. The reality they depict takes on the appearance of timelessness, of having always been there, as Creighton imagined the shield. Logan's contemporaries learned from the Geological Survey of Canada, through its influential

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[90] Zaslow locates the shift in attitudes beginning in the mid-1890s; see his *Opening of the Canadian north*, p. 173 ff.

[91] See E. Heaman, *The inglorious arts of peace* (Toronto: University of Toronto Press, 1999), p. 158; Zaslow, *Reading the rocks*, ch. 24, "Logan's Legacy."

maps, that their country's north was a fundamentally different place. This was visually evident even to the provincial public of southern Canada West as early as 1863, as a version of the GSC map reproduced in the Toronto *Globe* indicates (fig. 6).[92] The Laurentian dominates the land like a huge mass crushing down towards the south, showing just how bounded the Paleozoic-based agricultural lands were. If the twentieth century could come to see the Canadian shield as the single most salient fact of Canadian geology and geography, it was as a direct consequence of the migration of the GSC's technical results into the public consciousness, through discursive means such as reports, and through physically exhibited objects, but above all, in that the geological entities like the Canadian shield are fundamentally spatial phenomena, they were brought to life through the imaginatively-powerful visual medium of maps.

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[92] "Geological Survey of Canada," Toronto *Globe*, 26 December 1863, p. 2. The article suggests that the map and accompanying explanations were prepared by University of Toronto professor E. J. Chapman, one of Logan's key allies in that city.

Figure 1. GSC, *Geological map of Canada and the adjacent regions including parts of other British provinces and of the United States*...(1865). In *Atlas of maps and sections* (Montreal: Dawson Brothers, 1865). 49 cm x 21 cm. Original scale 125 miles : 1 inch. Source: MIRAGE database, Geoscience Data Repository, Geological Survey of Canada, Earth Sciences Sector, Natural Resources Canada.

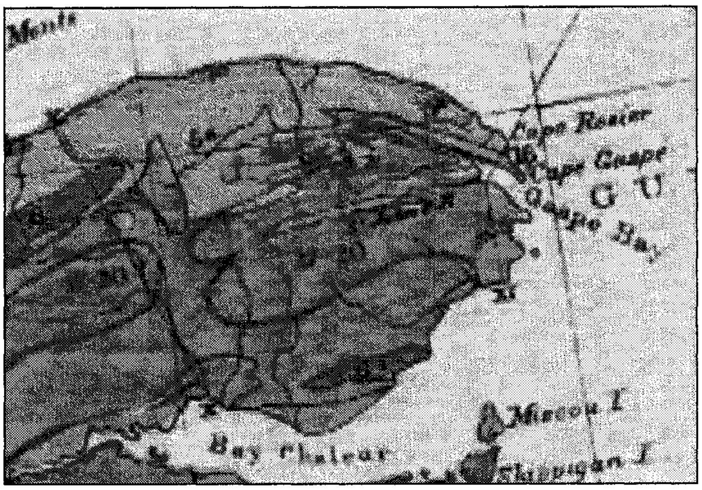

Figure 2. Detail: Gaspé peninsula (1865). From GSC, *Geological map of Canada*, 1865. Source: MIRAGE database, Natural Resources Canada.

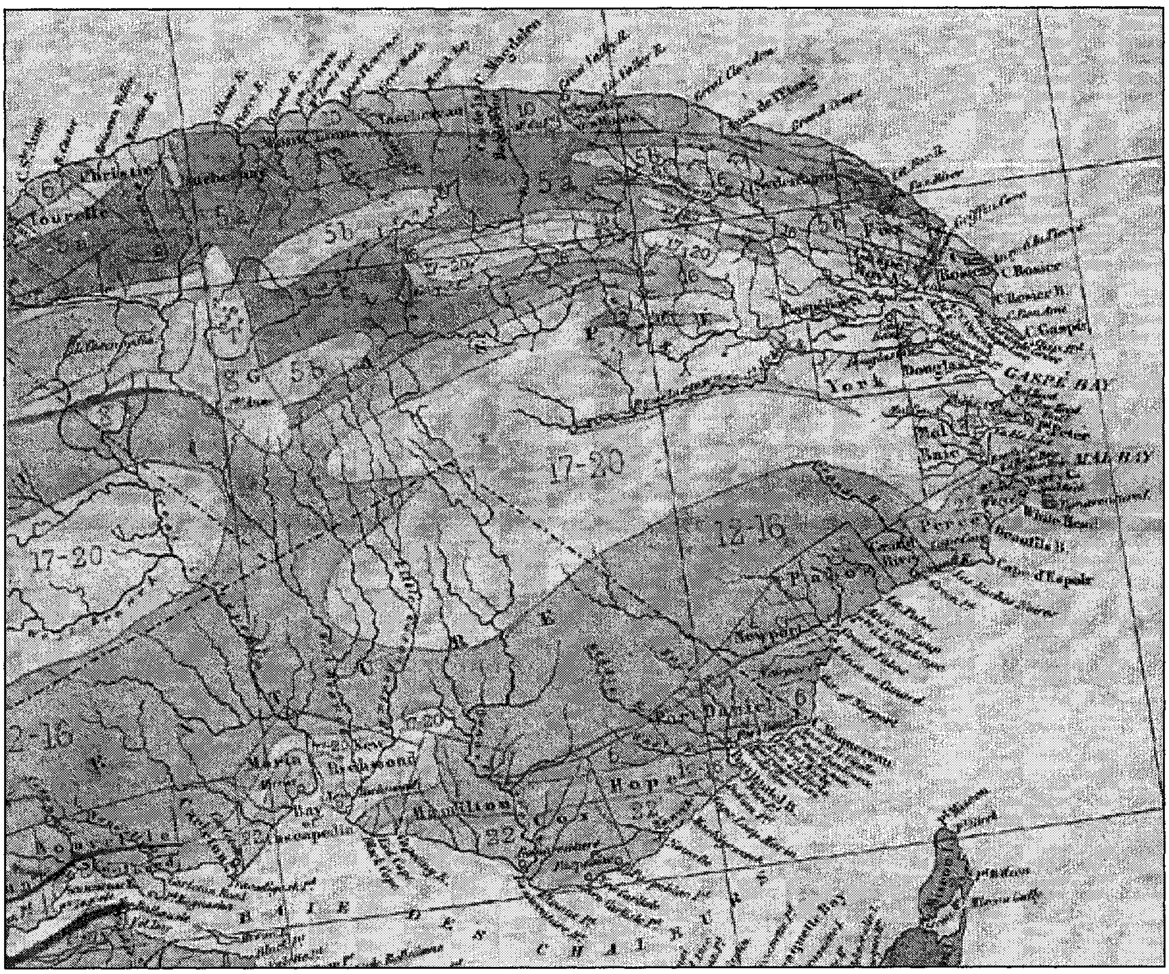

Figure 3. Detail: Gaspé peninsula (1869). From GSC, *Geological map of Canada*, 1869. Original scale 25 miles : 1 inch. Source: MIRAGE database, Natural Resources Canada.

Figure 4. Detail: Gaspé and Percé (1869). From GSC, *Geological map of Canada*, 1869. Original scale 25 miles : 1 inch (1:1 584 000). For key to numbered formations, see Legend (figure 5, below). Source: MIRAGE database, Natural Resources Canada.

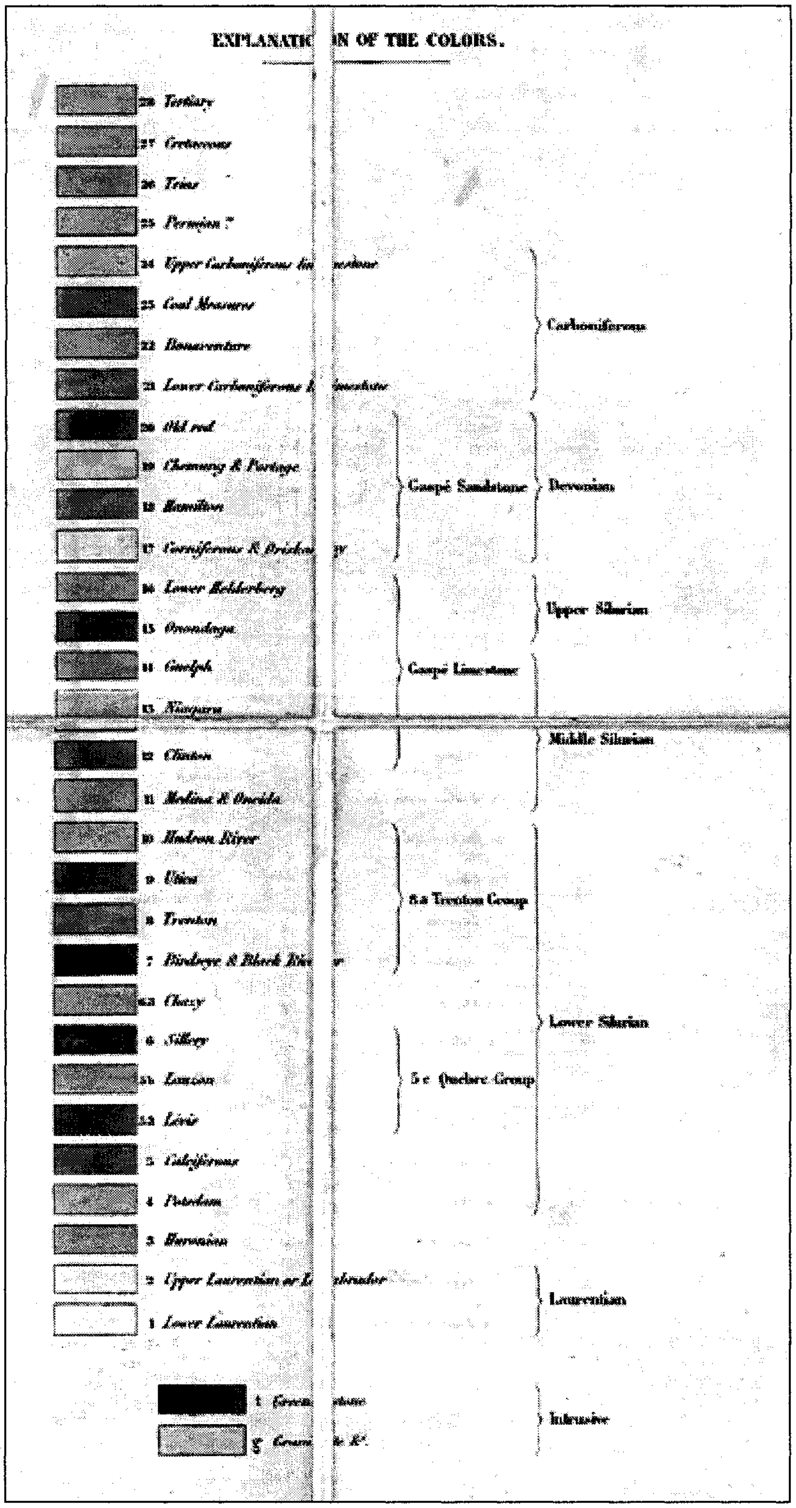

Figure 5. Detail: Legend (1869). From GSC, *Geological map of Canada*, 1869. Note that the Bonaventure formation (22), found along the south coast of the Gaspé peninsula, lay tantalizingly just below the Coal Measures (23), which existed right across the Bay of Chaleur in New Brunswick. Source: MIRAGE database, Natural Resources Canada.

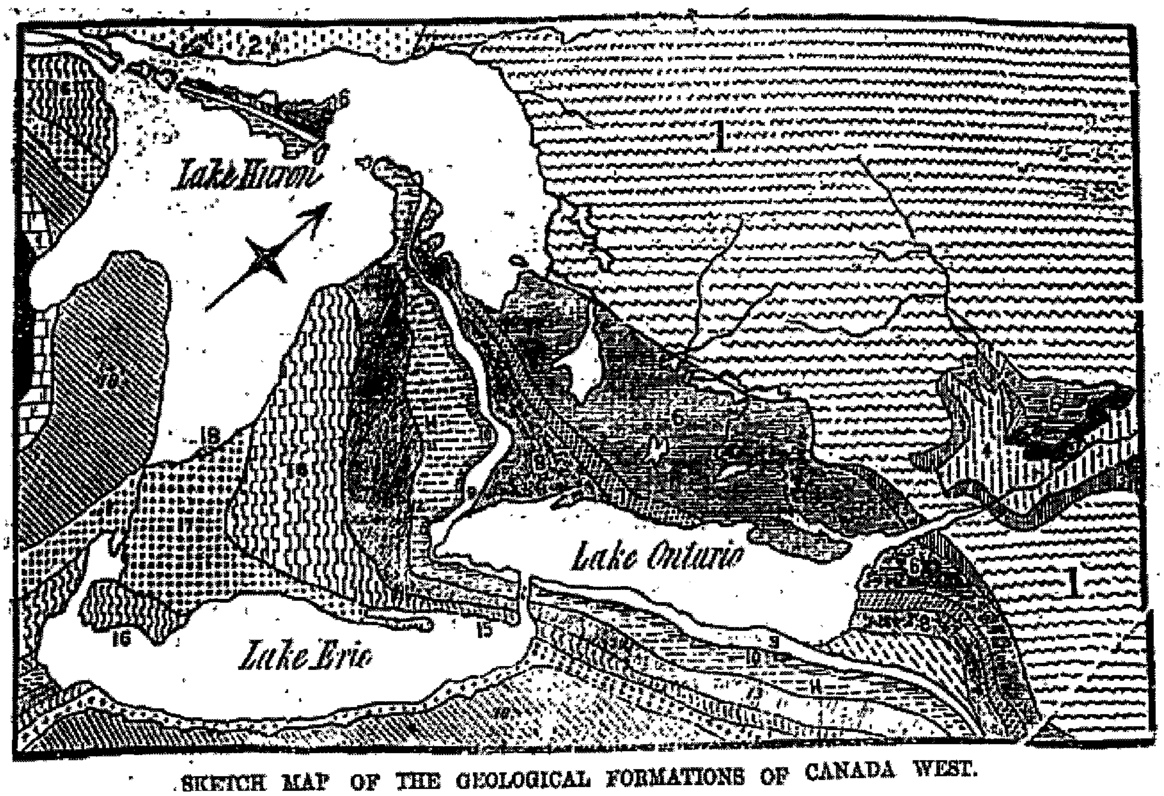

Figure 6. Sketch map of the geological formations of Canada West. From "Geological Survey of Canada," Toronto *Globe*, 26 December 1863, p. 2. Formation 1 is the Laurentian; 2 (top left corner) is the Huronian; the remainder are Silurian (3-14) and Devonian (15-18).
Source: Toronto *Globe*.

CHAPTER 7

Conclusion

> In whatever I do here you may be sure of this, that I will refer to nobodys System in coming to conclusions. Or perhaps I shall come to no conclusions at all but this one, that here run certain rocks of which the distribution is as per map & here are their contents, mineralogical & fossiliferous as per specimens. Let them who can make what they like of them.[1]

7.1 From Field to Fact

In concluding this dissertation I wish to reiterate two points and advance three more in the form of interpretations and suggestions for future research. First, there is the central observation that geological knowledge circulated in an economy that began when a scientist first laid eyes on an outcrop in the field, and continued to the point where a visitor looked at a coloured map affixed to a museum wall or a legislator referenced a fact published in an annual report while advocating a specific course of action. Along the way was an ongoing process of value added, in which Logan "disciplined" geological specimens by naming them, sorting them, describing them, mapping them, valuing them, collecting them, displaying them, cataloging them, and exhibiting them.

[1] W. E. Logan to H. T. De la Beche, 11 November 1844, DBP. Logan was exaggerating of course, just as I am in quoting him. This sentiment was, however, a recurring theme in a certain "Baconian" strand of Victorian natural history.

Secondly, there is the point that, underlain by the field practices of stratigraphy, the practical science of economic mineral distribution and the intellectual science of questions such as coal formation or the nature of the Laurentian formations were inseparable. Logan's scientific accolades indicate that what he did was "real" science, while his popular and political approval mean that his work was genuinely believed to have real value at the time: any dichotomy established between these two strands must be false. Both questions depended on the ability of the surveyor to translate field experience into transferable fact, because the geological structure of a region could only be unravelled (if at all) by extensive personal examination. It is telling that, when Logan began his geological survey, there were many possible answers to his questionnaire about what existed and where; by the end of the 1860s, thanks to both its methods and its results, the GSC had established itself as the sole authority in this sphere. Those who continued to insist, for example, that coal existed in the province of Canada, were marginalized and disparaged as hopelessly misguided.

As for new questions to broach, the first concerns the relationship between science and empire in this particular case. Despite a large body of literature on the topic, can we locate specifically "imperial" aspects of Logan's Canadian survey? Surveying projects elsewhere in the British empire, albeit different in many other respects, were conducted by visitors for imperial ends.[2] While it is true (and often mentioned) that the notorious geological and geographical powerbroker Sir R. I. Murchison dedicated the fourth edition of his signature oeuvre, *Siluria*, to William Logan, as if for services

[2] Again, one thinks particularly here of M. Edney, *Mapping an empire: the geographical construction of British India, 1765-1843* (Chicago: University of Chicago Press, 1997) and D. G. Burnett, *Masters of all they surveyed: exploration, geography and a British El Dorado* (Chicago: University of Chicago Press, 2000).

rendered, this seems like slender evidence upon which to hang a general diagnosis of imperial dependency on the part of Logan and Canada.[3] Given that Murchison described Logan as "the Geologist who has not only applied my classification to the vast regions of British North America, but has taught us by his recent important researches that the Laurentian Rocks constitute the foundation-stones of all Paleozoic deposits in the crust of the Globe," it seems clear that Logan benefited as much from Canada's relationship to Britain, in having the opportunity to have his Laurentian system adopted back home, as vice versa.[4] The twin facts that British stratigraphy was a science that sought worldwide application, and that the province of Canada was indeed a colony, mean that it is not inappropriate to discuss the GSC under the heading of imperial science. But we should be clear that we mean a dynamic kind of imperial relationship, in which the farthest-flung corner contributed as actively as the metropolitan point of origin, one in which imperial forms of knowledge production were constantly being renegotiated in the field (as seen in Chapter 2). By the 1860s, Logan's survey was atypical of much of what is usually classed as "colonial science," in that it was tightly organized and was applied in a cultural

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[3] R. Murchison, *The Silurian system* (London: Taylor, 1839; fourth edition, 1867). Recall that Murchison was simultaneously Director of the Geological Survey of Great Britain and President of the Royal Geographical Society for much of the period 1855-1871. The classic view of Logan as part of Murchison's global network is Robert Stafford's; see R. Stafford, *Scientist of empire: Sir Roderick Murchison, scientific exploration and Victorian imperialism* (Cambridge: Cambridge University Press, 1989); and R. Stafford, "Annexing the landscapes of the past: British imperial geology in the nineteenth century," in J. MacKenzie, ed., *Imperialism and the natural world* (Manchester: Manchester University Press, 1990), 67-89.

[4] Murchison, *Silurian system* (4th edition, 1867), dedication. This point is also recognized by S. Zeller, "The colonial world as a geological metaphor: strata(gems) of empire in Victorian Canada," in R. MacLeod, ed., *Nature and empire: science and the colonial enterprise*, *Osiris* (2nd series) 15 (2000), 85-107.

context that (relatively speaking) more or less resembled that of the home country.[5] Thus, it is probably more helpful to think of Logan and his British (and indeed American) homologues as working in tandem on a joint project to describe the world according to a shared classificatory system.

My second concluding suggestion concerns the Geological Survey of Canada in its colonial political context. Here, it seems very likely that the state formation framework elaborated by Ian Mackay, Bruce Curtis, and others makes a substantial contribution to our understanding of what the GSC was, how it worked in an informational sense, and why it is significant. While historical studies generally take humans as their subject, whether framed as "individuals" (McKay) or as "population" (Curtis), in their capacity as the objects of government, I would argue that geological surveyors were entirely congruent with census takers or education inspectors in generating a body of standardized, normalized data that could be deployed in developing and justifying state policies and actions.[6] John Walsh has made this argument for pre-Confederation land surveying, and Bruce Braun has done so for the case of post-Confederation geological surveying in British Columbia.[7] In the present dissertation, which does not begin to exhaust the scope of work undertaken by Logan's GSC, there

[5] M. Harrison, "Science and the British empire," *Isis* 96 (2005): 56-63. Harrison argues that "colonial science" is a label more of convenience than of particular analytic value.
[6] I. Mackay, "The liberal order framework: prospectus for a reconnaissance of Canadian history," *Canadian Historical Review* 81 (2000): 617-645; B. Curtis, *The politics of population: state formation, statistics, and the census of Canada, 1840-1875* (Toronto: University of Toronto Press, 2001).
[7] J. Walsh, "Landscapes of longing: colonization and the problem of state formation in Canada West," Ph.D. thesis, University of Guelph, 2001; B. Braun, "Producing vertical territory: geology and governmentality in late Victorian Canada," *Ecumene* 7 (2000): 7-46. This approach derives from Foucault's useful notion of "governmentality" but, as the epigraph announces, my goal is not to insist on a single theoretical framework.

have been at least three examples of the role of what I have called "environmental knowledge" (geological knowledge attached to specific points on the map): in supporting mining claim grants on the north shores of Lakes Superior and Huron, and thus in underwriting the context of the Robinson treaties; in providing a nuanced vision of the Laurentian formations of the Ottawa-Huron tract, implying that the region had a viable economic future; and in exhibiting and enumerating the distribution of raw materials across the province in order to support the possibility of domestic industrial development, a goal shared by London and Montreal alike. Recall that Logan had promised John Langton's Select Committee that his map would not only serve to indicate the geology at an observed point or two, but that it would give users inferred knowledge of what lay invisibly underground at "a hundred places in between" (Chapter 5). This manner of creating territory, and simultaneously making possible its administration, lets us appreciate that the GSC was very much a part of its colonial governmental context, and this adds an invaluable dimension to our understanding of its importance, at right angles to the existing axis of the rhetorical and intellectual support it gave to nation-building urges in the era of Confederation.[8] While these two views may be of different flavours, I do not see anything contradictory in them: the geological survey had always meant different things to different audiences, and it is perfectly legitimate that its results were employed differently by colonial land policy makers than by advocates of westward expansion, or for that matter by gentlemanly scientists in London.

Finally, we come to William Logan himself, the central point of my analysis and of historical memory of the GSC. Even if he did not originate the persona of the field

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[8] S. Zeller, *Inventing Canada: early Victorian science and the idea of a transcontinental nation* (Toronto: University of Toronto Press, 1987).

geologist, that cross between an Enlightenment traveller (class gentleman) and an itinerant coal viewer (class tradesman), he certainly exemplified it for once and for all in the Canadian context.[9] This type was rugged, devoted, careless of personal well-being, dressed in the most battered of clothes, spending every minute of daylight at the rocks and staying up long into the night to work on his notes, drawings, and calculations; and frequently taken for an idiot or a fool by a local population incapable of grasping what was unfolding. Created in the first instance as a means of self-reflection in his field journals, this image was propagated by his followers in their after-dinner remarks, obituaries, poems, pamphlets, and official biographies.[10] The photographic collections of the Geological Survey, held at Library and Archives Canada, contain many an image of scruffy surveyors in field camps staring out at the camera, each of them following in Logan's footsteps, their ungentlemanly demeanour warranting rather than detracting from their scientific credibility. In 1891, the highest mountain in Yukon's Mount St. Elias Range was named for Logan, the attempted renaming of which in 2000 only served to bring the original commemorative and celebratory masculine (or homosocial) attitudes back to the fore, according to one analysis.[11] In the 1940s, National Museum curator F.

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[9] On the notion of scientific "personae," see L. Daston & H. O. Sibum, "Introduction: Scientific personae and their histories," *Science in Context* 16 (2003): 1-8.

[10] In addition to sources cited elsewhere, see S. Fleming, "The Canadian Geological Survey and its director, Sir William Edmund Logan, Kt. F.R.S." (Read before the Canadian Institute, February 23rd, 1856), CIHM 64032; B. Harrington, "Sir William Edmond Logan. Obituary notice read before the Natural History Society of Montreal, October 25th, 1875," *American Journal of Science and Arts* 11 (February 1876); T. S. Hunt, "Notice of Sir William Edmond Logan," (*Report of the Council of the American Academy of Arts and Sciences*, May 1876), CIHM 62073. On the resonance of such stories with the audience for late nineteenth-century adventure fiction, see R. Phillips, *Mapping men and empire: a geography of adventure* (London: Routledge, 1997).

[11] B. Erickson, "The colonial climbs of Mount Trudeau: thinking masculinity through the homosocial," *Topia* 9 (2003): 67-82.

J. Alcock asserted that "Succeeding generations of geologists of the Geological Survey of Canada, including those of the present day, though they have not known Logan personally, have always felt in much the same way about him as did their predecessors who worked with him," indicating that the memory was not only fresh, it was unquestioningly taken to be accurate.[12] With long extracts published in B. J. Harrington's biography, Logan's Gaspé field journals finally found their audience and began to have the effect on others that they had had on Logan himself.[13]

By 1875, Logan had been in retirement for several years, though he had continued to pursue pet projects in the Eastern Townships. In May, however, he wrote (critically, it must be admitted) to his old American friend James Hall from his sister Eliza's house at Castle Malgwyn, near Cardigan in South Wales: "I am sorry to say that my health has completely broken down. I have been for twelve weeks in bed, from which I have just risen in a state of great prostration both physically and mentally. I shall not return to Canada. All geological work for me is at an end."[14] As true as that was, in another sense Logan's distinctive field geologist identity lived on and continued to do "work" after him, inflecting the social, cultural, and gender history of Canadian geology.

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[12] F. Alcock, "Logan: reminiscences of a great work and a great man," *Canadian Mining Journal* 62 (1941): 373-378, p. 378; Alcock became curator in 1947. For a similar piece, including a wholly-imagined drawing of Logan at work, see G. Cuthbertson, "Historical note: Sir William E. Logan at work in Gaspé, 1843," *Canadian Mining Journal* 60 (1939): 286-288.

[13] On scientists' writing, see J. Golinski, "The care of the self and masculine birth of science," *History of Science* 40 (2002): 125-145. B. Harrington, *Life of Sir William E. Logan* (Montreal: Dawson Brothers, 1883).

[14] W. E. Logan to J. Hall, 10 May 1875, James Hall Papers, New York State Library. Logan specified, "My complaint is an enlargement of the prostate gland, and no prospect of a complete recovery is held out to me." After a brief recovery, he died on 22 June. On Eliza Logan and Castle Malgwyn, see J. R. Phillips, *The history of Cilgerran* (London: J. Russell Smith, 1867).

As laid out in the Introduction, this dissertation has sought to revisit our existing broad knowledge of William Logan and the first generation of the Geological Survey of Canada, in augmenting it with a series of cross sections, sometimes digging vertically through the strata, sometimes running horizontally along the surface, inspired by a diverse array of historiographical perspectives. Having done so, and in concluding with these larger themes that illustrate the breadth of field that exists for future studies, I also hope to have reaffirmed that the history of colonial Canadian field science offers rich veins of ore to be mined by historians of science and historians of Canada alike.

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1/12 Director's Letterbook
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1/67 (add.) thirteen Logan field notebooks, 1837-1842
1/123 (ii) De la Beche notebook (undated)
1/218 "Notes and sections relating to the S. Wales Coalfield by WEL, 1836-1842" (bound volume, ca. 500 pp.)

Oxford University Museum of Natural History, Oxford
John Phillips Papers

National Library of Wales, Aberystwyth
Gower Family Papers, Glandovan Collection, Archives
*William Logan 1843 (Gaspé) Journal, MS 21715B
*William Logan 1844 (Gaspé) Journal, MS 21716B

Department of Geology, National Museum of Wales, Cardiff
Henry T. De la Beche Papers

Swansea Museum, Swansea
Royal Institution of South Wales Papers

Edinburgh University Library, Edinburgh
Charles Lyell Papers, Gen. 113/3500-01

United States

New York State Library, Albany
State Natural History Survey, Director's Papers

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Government Documents

i) Geological Survey of Canada, Annual Reports of Progress (RP)[1]

RP Year	*Filed*	*JLA*	*Appendix*
1842, 1843	Jan 1845	1844-5	W
1844	May 1845	1846	GGG
1845	May 1846	1847	C
1846	May 1847	1847	C
1847	May 1848	1849	G
1848	Dec 1848	1849	G
1848	May 1849	1850	V
1849	May 1850	1850	V
1850	Aug 1851	1852	O
1851	May 1852	1852	O
1852	May 1853	1854	L
1853-54-55-56	Mar 1857	1857	No. 52
1857	Mar 1858	1858	No. 32
1858	May 1859	1859	Sess. P. 24

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[1] For contents of each Report, see GSC, *Atlas of maps and sections*, Appendix 1; and A. G. Johnston, *Index of publications of the Geological Survey of Canada* (Ottawa: Department of Mines and Technical Surveys, 1961). For online versions of the Reports as published in JLA, see http://www.collectionscanada.ca/logan/021014-3300-e.html.

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