Scientia Canadensis
Canadian Journal of the History of Science, Technology and Medicine
Revue canadienne d'histoire des sciences, des techniques et de la médecine

Australian-Canadian Links in an Imperial Geological Chain: Sir William Logan, Dr. Alfred Selwyn and Henry Y.L. Brown

Suzanne Zeller et David Branagan

Volume 17, numéro 1-2, 1993

Dominions Apart: Reflections on the Culture of Science and Technology in Canada and Australia 1850-1945

URI : https://id.erudit.org/iderudit/800365ar
DOI : https://doi.org/10.7202/800365ar

Aller au sommaire du numéro

Éditeur(s)

CSTHA/AHSTC

ISSN

0829-2507 (imprimé)
1918-7750 (numérique)

Découvrir la revue

Citer cet article

Zeller, S. & Branagan, D. (1993). Australian-Canadian Links in an Imperial Geological Chain: Sir William Logan, Dr. Alfred Selwyn and Henry Y.L. Brown. *Scientia Canadensis*, *17*(1-2), 71–102. https://doi.org/10.7202/800365ar

Australian-Canadian Links in an Imperial Geological Chain: Sir William Logan, Dr. Alfred Selwyn and Henry Y.L. Brown

Suzanne Zeller and David Branagan

Introduction[1]

During the middle decades of the nineteenth century geology enjoyed immense popular appeal in Victorian societies, not only in Great Britain, but also in Australasia and North America. Audiences gathered to hear famous lecturers: newspapers reported the discovery of dinosaurs and mammoth remains. Moreover the amateur naturalist tradition in British culture valued the collection of fossils as both a healthy physical recreation in the open air, and a morally uplifting preoccupation that affirmed the earth as God's design.[2] Furthermore, geology's practical value was readily apparent. Geology could help to locate useful materials such as coal, metals and building stones; to analyse soils; and to assess the stability of slopes, dam sites and tunnels.[3]

Pioneers in geology during the 18th century included James Hutton (1726-97), Antoine Lavoisier (1743-94), Abraham Werner (1750-1817), and William Smith (1769-1839).[4] By the nineteenth century, their influence was evident in the work of the Oxford professor William Buckland (1784-1856), who inter-

1 We are grateful to Richard Jarrell and Roy MacLeod for the invitation to present papers at the Canada-Australia Workshop held at Victoria University in 1990. The chapter presents those papers, together with an introduction and an epilogue which attempt to place these biographies in a wider context. The chapter owes much to discussion with colleagues and constructive editing by the editors. We also express our thanks to Dr. T.A. Darragh, Museum of Victoria; the late Professor T.G. Vallance; and the H.H. Selwyn family of Quebec. The staff of the State Archives of Victoria, Australia, the National Archives of Canada, and Imperial College, London, have also been most helpful.

2 David Elliston Allen, 'The Lost Limb: Geology and Natural History,' in L.J.Jordanova and Roy S. Porter (eds), *Images of the Earth: Essays in the History of the Environmental Sciences* (Chalfont St Giles: British Society for the History of Science (BSHS Monograph), 1978), 206.

3 T.G.Vallance and D.F. Branagan, 'New South Wales Geology – its Origins and Growth,' in *A Century of Scientific Progress* (Sydney: Royal Society of New South Wales, 1968), 265.

4 On Hutton, see Douglas A. Robson, *Pioneers of Geology* (Newcastle-upon-Tyne: The Natural History Society of Northumbria, 1986), 19; on Lavoisier, *ibid,* 14; on Werner, *ibid,* 16-18;.on Smith, *ibid,* 25-27.

wove geology's theoretical and practical aspects. This chapter discusses British geological influences upon Canada and Australia, in particular, through the careers of Sir William E. Logan (1798-1875), Alfred R.C. Selwyn (1824-1902), and Henry Y.L. Brown (1844-1928), which highlight important scientific and cultural links between the two Dominions.

Geology constituted a dynamic component of British imperialism during the 19th century. Its success through the Geological Society of London (f.1807) and especially the Geological Survey of Great Britain (f.1835) established a pattern of development in many British colonies from the 1840s. This development accelerated after the Californian gold discoveries in 1847. The formation of colonial surveys after 1840 enjoyed public support in tune with the considerable popular interest in geology. The director-general of the British survey, Sir Henry De la Beche, played a key role in the organization of these colonial surveys, recommending or supporting the appointments of geologists, mostly from the ranks of his own institution. Indeed, the resulting exodus of younger geologists, easily attracted by higher salaries offered for overseas appointments, gave De la Beche some cause for grumbling from time to time. Yet this metropolitan control of patronage continued under his successors, Sir Roderick Murchison from 1855 and Sir Andrew Ramsay from 1871.[5]

The reason for this control was clear enough. The only training ground for practical geology in Britain, let alone its colonies, was the Geological Survey of England and Wales. Set up in London during the 1840s, the Survey, and the Royal School of Mines and the Museum of Practical Geology, were intended to educate both surveyors and the public in the methods and of the subject. Training for the Survey combined geological theory with extensive practical fieldwork under the tutelage of an experienced geological surveyor.[6] While well-established schools of mines in France, Germany and elsewhere on the continent provided alternative models, the Geological Survey remained a determinedly British institution that discouraged the entry of foreigners into its ranks. Such an exclusive rule, however, could not apply as rigidly in colonial surveys, with their chronic staffing shortages.[7]

The foundations of these geological surveys contained the seeds of their future difficulties. Intended ostensibly for practical purposes, they raised expectations that those employed would devote their attention to geological applications. By implication, an interest in theoretical questions was discouraged as a

5 Robert A. Stafford, *Scientist of Empire* (Cambridge: Cambridge University Press, 1989), 116.

6 Henry T. De la Beche, *The Geological Observer* (London: Longman, Brown, Green and Longman, 1851), 821-828.

7 On the European schools, see Rossiter W. Raymond, *Mineral Resources of the States and Territories west of the Rocky Mountains* (Washington, DC: Government Printer, 1869), 238-244. On appointments, see Stafford *op. cit.* note 4, 54-57 and 119.

waste of public funds. Politicians and bureaucrats, furthermore, allotted them limited time within which to complete investigations. Geological surveyors worked hard to disabuse their governments of deeply held assumptions that geological 'facts' could be established once and for all, and that mineral finds would follow each survey inevitably, if not immediately. As early as 1840, De la Beche defended his Survey against criticism, even from other geologists, that his organization spent too much time on theoretical matters. This theme echoed through both the Canadian and Australian surveys in later years. In Melbourne, A.R.C. Selwyn resigned when the Victoria Geological Survey lost its funding in 1868 in a dispute over the proper balance of its practical and theoretical priorities; in Canada, William Logan's Survey benefited from the similar experience of J.B. Jukes in Newfoundland in 1839, and devised strategies to circumvent such threats to its existence.

By the 1860s, the widespread popularity of geology was declining for several reasons. The evolutionary theories of Charles Darwin and Alfred Russel Wallace eclipsed the study of fossils in favour of living subjects such as botany and zoology. Moreover, geology's failure to capitalize on palaeontological links to the theory of evolution was reinforced by the staunch anti-evolutionary stand taken by the influential comparative anatomist Richard Owen.[8] Despite the appearance of the later editions of Charles Lyell's *Principles of Geology*, and the later successful popular volumes by Archibald Geikie and others, further theoretical developments followed from the increased sophistication of the microscope and chemical analysis, in turn enhancing the image of geology as complex theoretical science. Finally, Lord Kelvin's physical evidence of limitations on the age of the earth further reduced geology in the 'pecking order of science' as the nineteenth century drew to a close.[9]

The increasing specialization and fragmentation of geology diminished popular understanding of, participation in and enthusiasm for the delights of the subject. As a result, geological surveys remained vulnerable, particularly in times of financial restraint. The essential symbiosis of field mapping and laboratory studies, of theory and practice, in the long run was not easily appreciated by politicians, whose more short-term interests demanded tangible results quickly.

The geologists Sir William Logan, Dr Alfred Selwyn and Henry Y.L. Brown held important positions in Canada and/or Australia, during the heyday of geology in Victorian culture, between 1842 and 1912.[10] An interesting

8 Allen, *op. cit.* note 1, 205.

9 Allen, *ibid.*, 207.

10 Of the three, only Logan has been honoured with a full biography; B.J. Harrington, *Life of Sir William Logan* (Montreal: Dawson Bros., 1883). At the time of his death several significant obituaries were written for Selwyn: viz. H.M. Ami, 'Memorial or sketch of the life of the late Dr. A.R.C. Selwyn CMG....,' *Transactions of the Royal Society of Canada*,

sequence links their lengthy careers in these two developing societies: both Logan and Selwyn began their geological survey work in Wales, impressing the staff of the Geological Survey of Great Britain with the accuracy of their fieldwork, as well as of their topographical maps and cross-sections. Trained in the methods and standards of the British Survey, Logan and Selwyn also left their marks on both before proceeding to colonial survey work.

Logan returned to his native Canada in 1840, and was appointed founding director of the geological survey of the province in 1842. Ten years later Selwyn moved to Victoria, Australia, to begin, and eventually to direct, formal surveys of the colony. In 1869 Selwyn left Australia as Logan's choice to succeed him as Director of the Geological Survey of Canada.[11] The much younger Brown, of Sydney, Nova Scotia, was a son of Richard Brown, himself an associate of Logan. After training at the Royal School of Mines, he became a protégé of Selwyn, first in Victoria and then in Canada. Brown then undertook extensive surveys in Western, South and North Australia continuing the principles of geological mapping introduced in Australia by his mentor.[12]

While contemporaries recognized and acknowledged the quality of the scientific work of these three geologists, assessments of their respective careers as public servants have varied.[13] In particular Logan's contribution to geology,

second series, Vol. X, sect. IV (1904-05),173-205. and A.E. Barlow, 'Dr. Alfred R.C.Selwyn, C.M.G., F.R.S., Director Geological Survey of Canada, 1869-1894, '*The Ottawa Naturalist*, XVI (9), 170-177. More recent assessments are by D.F. Branagan and K.A. Townley, 'Selwyn, Alfred Richard Cecil,' in B.Nairn (ed.), *Australian Dictionary of Biography*, 6, 1851-1890, (1976), 102-103, and D.F. Branagan, 'Alfred Selwyn, 19th Century Trans-Atlantic Geological Connections, via the Antipodes,' *Earth Science History*, 9 (2), (1990), 143-157. Brown's life is covered briefly by P. R. G. Dunlop in B. Nairn and G. Searle (eds), *Australian Dictionary of Biography*, 7, 1891-1939, (1979), 439-440. Many aspects of his South Australian career are discussed by Bernard O'Neil, *In Search of Mineral Wealth: The South Australian Geological Survey and Department of Mines to 1944*. (Adelaide: Department of Mines and Energy, South Australia, 1982), Special Publication No. 2, 359.

11 Logan's official work in Canada began in 1843. Logan, like Samuel Stutchbury of Bristol, gave his services freely to Henry De la Beche, Director of the Geological Survey, at a time when the Survey's official assistants were learning their trade, i.e. prior to 1840. Although learning from De la Beche, Logan made a major contribution to survey methods by using chain, theodolite and level to obtain topographical detail so that detailed cross-sections at a scale of 6 inches to a mile could be drawn. E. Bailey, *Geological Survey of Great Britain* (London: Murby, 1952), 33. This technique was used extensively by Selwyn in his mapping in North Wales from 1846.

12 Information on the Brown family can be found in the Public Archives of Nova Scotia, f. 1-629, 1-1667. Morris Zaslow (*op. cit.* note 12) does not list Brown as an employee of the GSC.

13 For more critical assessments of Logan's later scientific work, see note 15. Morris Zaslow, *Reading the Rocks: The story of the Geological Survey of Canada, 1842-1972*. (Ottawa:

to the Geological Survey of Canada, as well as to Canadian history are generally well-known and acknowledged. In contrast Selwyn's scientific work in Australia is likewise recognized, albeit less well known: yet his role in Canada, during the transcontinental expansion of the Dominion from 1869 until his retirement in 1895 has been either largely ignored or adversely criticized.[14] Brown's similar work in Australia is only now receiving attention.[15]

A number of factors help explain these differences in the apparent success, or failure, of these three geologists in their attempts to carry out their public mandates: individual personality and social background; attitudes to government, bureaucracy and interest groups; public relations and perceptions; geographical and geological environments of the colonies; relations of the colonies to the Mother Country. The following papers develop these themes, highlighting similarities and differences in attitudes to geological work and related matters in Canada and Australia between 1840 and 1912.

– I –
Batting Cleanup: Logan, Selwyn and the expansionist Matrix of Geology in Victorian Canada

1. *Logan and Selwyn*

The careers of the first two directors of the Geological Survey of Canada (GSC) have received quite an uneven press from Canadian historians. While Sir William Logan [Director, 1842-69], personified the early survey and could do no wrong, A.R.C. Selwyn [Director, 1869–95], when his career is noticed at all, could do too little right. The historical literature has tended to contrast Logan's political acumen in ensuring the survival of the Canadian survey, even when he concluded that the province contained no workable coal deposits, with Selwyn's negative experience when public support for his survey was withdrawn under similar circumstances in Victoria, Australia; Logan's admirable organizational and administrative skills with Selwyn's obvious dislike of his increasingly bureaucratic responsibilities; Logan's highly developed social and managerial talents with Selwyn's reportedly brusque and allegedly unfair treatment of his staff; and Logan's more positive public image for balancing

Macmillan of Canada, 1975),105-110, 138-139 discusses some of the new problems which Selwyn faced in Canada as compared with Logan, but his comparison of their scientific attainments in favour of Logan (p. 101) is quite bland. Zaslow gives a fair assessment of Selwyn's contribution to the Canadian Survey, p. 149. See also note 9. Branagan,1990, and O'Neil, 1982.

14 See note 15.

15 See note 9; O'Neil, and B.J. Cooper, 'Early geological mapping in South Australia,' *The Globe*, No.27, (1987),11-33; D.W.P. Corbett, B.J. Cooper and P. Mooney, 'Geology', in *Ideas and endeavours- the Natural Sciences in South Australia.* (Adelaide: Royal Society of South Australia, 1986), 29-67.

Canada's economic and scientific needs with Selwyn's more negative reputation for giving priority to matters more strictly academic, and for defying the practical consequences of his rejection of a more entrepreneurial approach. Finally, as one is often reminded, Logan was a native Canadian while Selwyn was not, and the latter suffered from the deep resentments built up against him by Canadians who coveted his position.[16]

While a thorough analysis of Selwyn's Canadian career awaits its author, this paper suggests an important additional factor that tarnished Selwyn's legacy in Canada. Logan's main survival strategy during the early years of the Geological Survey of Canada may well have set up the successor to whom he personally bequeathed his survey for an inevitable fall.

> Just look at Arrowsmith's little map of British North America. You will see that Canada comprises but a small part of it. Then examine the great rivers and lakes which water the interior between that American Baltic, Hudson's Bay, and the Pacific Ocean, some of the rivers as great as the St. Lawrence, and some of the lakes nearly as large as our Canadian internal seas, with a climate as I am informed, gradually improving as you go westward, and becoming delightful on the Pacific. It will become a great country hereafter. But who knows anything of its geology? Well, I have a sort of presentiment that I shall yet, if I live long enough, be employed by the British Government ... to examine as much of it as I can, and that I am here in Canada only learning my lesson, as it were, in preparation.[17]

When William Logan exhorted his mentor Sir Henry De la Beche in these exhilarated expansionist terms in 1845, Logan had only recently undertaken the geological survey of the united province of Canada, surely a task sufficiently daunting to satisfy anyone's lifetime ambition. Logan's survey had initially been granted £1,500 by the colony's Legislative Assembly for two years only, and he was well aware of the insufficiency of this limited mandate to 'float him over 25° of longitude and 10° of latitude,' even with the help of his one assistant, Alexander Murray. In rational terms, Logan accepted these

16 The official history of the GSC is Zaslow, *op. cit.* note 12; the series on the 'History of Canadian Geologists' published in the *Geological Association of Canada Proceedings,* 23 (1971) and 24 (2), (1972) excludes Selwyn; nor does Vittorio De Vecchi, *Science and Government in 19th-Century Canada,* (unpublished Ph.D. dissertation, University of Toronto, 1978) focus on him. But see C. Gordon Winder's entry in *Dictionary of Scientific Biography,* 12, 292-4. A more detached imperial overview is found in Stafford, *op. cit.* note 4, but some of the nuances are lost. More critical assessments of Logan's later scientific work have recently appeared, including William E. Eagan, 'I would have sworn my life on your interpretation: James Hall, Sir William Logan and the 'Quebec Group,' *Earth Sciences History,* 6 (1), (1987), 47-60; and his 'Is There a Huronian Group? The Debate over the Canadian Shield, 1880-1905,' *Isis,* 80 (June 1989), 232-53.

17 McGill University Archives [MUA], Sir William Edmond Logan Papers [henceforward, LP], Logan to Sir Henry De la Beche, 12 May 1845; also reprinted in Harrington, *op. cit.* note 9, 234-5.

limitations: he would, he realized, 'never be allowed to descend into such minutiae as to ascertain whether small divisions of strata in one part of the province are contemporaneous with certain small divisions in another. I shall not,' he admitted to De la Beche, 'be able to do more than to arrange a general skeleton of the subject.' Indeed, Logan's own preliminary report, addressed to the governor general in 1842, established the principle that for the foreseeable future his survey would not proceed far beyond the limits of settlement, which were confined to a narrow band along the southern fringe of the province.[18]

Yet the entire mode of Logan's geological survey belied these rational intentions. As early as his Report of Progress for 1843 he believed that unique contingencies in Canadian landforms were conspiring to expand the geographical horizons of his narrow preliminary vision, a faith derived from two main sources. First, Logan's own training in stratigraphy and his acceptance, by this time, of the principles of uniformitarian geology laid the conceptual groundwork for expansionist approaches to geological surveying. Second, the social community that sponsored his survey accepted territorial expansion as a desirable solution to problems exposed by Logan's own investigations. Under Logan's direction the Geological Survey of Canada regularly turned to the possibility of expanding its purview as a means of sustaining public interest in its activities. Logan's retirement in 1869, just when Confederation realized this optimistic vision, left Selwyn to bat clean-up with odds stacked heavily against his ability to live up to popular expectations of untold mineral wealth and continuous material progress.

2. *William Logan – Practical and Theoretical Geologist*

As directors of 'colonial' geological surveys in Canada and Victoria during the middle decades of the 19th century, Logan and Selwyn shared common professional roots in the imperial metropolis. Each had trained as a stratigrapher in Britain, and each had earned scientific reputations through the Geological Survey of Great Britain and the Geological Society of London, both for their excellent topographical and highly detailed cross-sections of the Welsh terrain. Of the two it was Logan, however, who drew upon a more diverse personal experience as a scientific businessman. Born in Montreal and educated at the University of Edinburgh, he there imbibed, through Professor Robert Jameson, Wernerian geological assumptions which classified rocks according to their position in the ordered strata of the earth's crust and emphasized the location and identification of minerals *in situ*, i.e. where they were formed. Employed in his uncle's mining and construction interests for twenty-four years after 1816, Logan devised practical geological applications

18 LP, Alexander Murray, *Anecdotes of the Life of Sir W.E. Logan* (unpublished ms), 9; Logan to De la Beche, 11 November 1844; and Logan, 'Remarks on the Mode of Proceeding to Make a Geological Survey of the Province,' September 1842.

especially while managing the Forest Copper Works at Swansea, South Wales, from 1831, in order to exploit more efficiently regional coal-seams needed to smelt the copper. The lucrative economic relationship of coal to copper impressed him indelibly and gave shape to his subsequent Canadian investigations.[19]

To Logan's benefit, traditional stratigraphical axioms were just then being recast in a clearer conceptual framework through the uniformitarian synthesis offered by Charles Lyell's *Principles of Geology* (1830-33). Lyell postulated long term geological processes generated by essentially the same forces that were recognizable in his own day. A great admirer of Lyell's interpretation, Logan in 1837 began publishing evidence of a direct relationship between coal-seams and Stigmaria *ficoides*, rootlike formations almost invariably present in the underclay below the coal. His suggestion to the Geological Society of London in 1840 that the plants actually formed coal *in situ* earned the approbation of eminent geologists who had for years been trying to explain the origins of the precious fossil fuel.[20]

The possibility that Canadian geological structures might be hoarding valuable minerals waiting to serve the advance of 'civilization' had piqued Logan's interest for years. Prompted in 1833 by news of copper discovered in Connecticut and Nova Scotia, he fully anticipated that similar Canadian deposits would be found within reach of the St. Lawrence River. The self-described 'practical coal miner of education' left Swansea in 1840 to visit his brother, a prominent Montreal businessman whom he had alerted to such possibilities, en route to test his coal theory in eastern North America. At Pictou, Nova Scotia, he met Lyell (on his first North American tour) and, at Sydney, N.S., the mine manager and geologist, Robert Brown, who led the visitors to the significant geological outcrops in the region. Lyell appreciated these formations within the context of uniformitarian geology as unique repositories of valuable cosmological information, instead of mere primitive versions of European structures. Lyell

19 On Wernerian geology, see Roy Porter, *The Making of Geology: Earth Science in Britain 1660-1815* (Cambridge, 1977), 152, 171-73; on the growth of stratigraphy, see Martin J. S. Rudwick, *The Meaning of Fossils: Episodes in the History of Palaeontology* (New York: Science History Publications, 2nd ed., 1976) and his *The Great Devonian Controversy* (Chicago: University of Chicago Press, 1985), 49-60; on Logan, see Suzanne Zeller, *Inventing Canada: Early Victorian Science and the Idea of a Transcontinental Nation* (Toronto: University of Toronto Press, 1987), 42-44, 66.

20 William Logan, 'On the Character of the Beds of Clay Lying Immediately Below the Coal Seams of South Wales,' *Geological Society of London Proceedings*, 3/69 (1840): 275-77, full text in *GSL Transactions*, ser. 2, 6 (1842): 491-97; Logan, 'On the Coal-Fields of Pennsylvania and Nova Scotia,' *GSL Proc.*, 3, Part I (1842): 707-12, *Montreal Gazette*, 9 November 1841; R.I. Murchison, Presidential Address, *GSL Proc.*, 4, Part I (1843), 121-22; Zeller, *op. cit.* note 18, 43-45. It was soon realized that *Stimaria ficoides* was not a separate plant, but the roots of the abundant coal measures plant *Sigillaria*.

urged Logan to explore British North American formations inclusively, i.e., by geological period, rather than exclusively by geographical region or political unit.[21]

Logan intended to do just that, and he remained in North America until October 1841. Aware of the Canadian government's intentions even before funding for a geological survey was approved in September, he considered offering himself as a candidate while he was still visiting Montreal (and making himself visible by geologizing on Mount Royal). Logan enjoyed important social and business links with the same Montreal commercial community that had helped initiate the geological survey through the local Natural History Society some years before, and which then sustained the project through political vicissitudes that delayed the actual appointment of a provincial geologist. More important, key members of the Montreal business community mounted a campaign to see Logan, as one of their own, named to the position, despite objections from the president of the Natural History Society that neither Logan's palaeontological skills nor his experience with North American geology sufficed for the task. Contrary to the imperial perspective exemplified by Robert Stafford's recent biography of Sir Roderick Murchison of the Geological Survey of Great Britain, in which Stafford writes that both the survey and Logan's appointment resulted directly from initiatives by Governor General Sir Charles Bagot and British geologists, the Canadian survey actually predated Bagot's accession to office in 1842 and derived largely from local economic interests revived after the Rebellions of 1837; and the choice of Logan rested equally upon his public image in Montreal as someone who knew how to locate coal, copper, iron ore, and other minerals considered indispensable to the British model of industrialization, and who was equally determined to accomplish this task. Logan created the impression that if anyone could attain this goal in Canada, it was he.[22]

3. *Logan – An Expanding Matrix for the Canadian Survey*

Based upon his background, experience, and mandate, Logan constructed an expansionist matrix for the Geological Survey of Canada in three successive stages: 1) from 1843 to 1850, his reports of progress reflected an expansionist impulse intended to counterbalance limitations imposed by his own scientific findings; and 2) from 1851 to 1856, he cemented his own scientific authority by earning international recognition for his geological investigations. Finally, 3) from 1857 to 1869, he expanded his survey unofficially into other British North American colonies.

21 Quoted in Harrington, *Life of Logan*, 50-51; Zeller, *op. cit.* note 18, 43-45.

22 Zeller, *op. cit.* note 18, chap. 2; contrast Stafford, *op. cit.* note 4, 65.

Logan's first task, as he saw it, was to outline the general geological contours of the province with a view to pinpointing possible locations of workable coal deposits. At the very least, he expected that outliers of the great eastern coalfields of North America might reach into Canada. Logan's initial reconnaissance led him to distinguish three main geological districts: his Western Division encompassed a 'well-marked zone of limestone,' the major structural feature of the southwestern part of the province, stretching along the north shore of the St. Lawrence to Quebec City; his Eastern Division ran along the south shore of the St. Lawrence to Labrador and Gaspe; and his Northern Division formed a rocky spine across the top of both. Confident that limestone was generally barren of both coal and metallic ores,[23] Logan read the Western Division as a signpost to these desiderata: 'Geological experience,' he assured his sponsors, 'teaches that the metalliferous rocks are below, the carboniferous above' the limestone. Yet this geological rule of thumb implied that the Western Division lay too low down in the stratigraphical sequence to contain Carboniferous coal deposits. By 1844, he was forced to admit, in a report that was published only two years later, the same for the more violently contorted Eastern Division, and to conclude reluctantly that no workable coal would ever be found within the confines of the province. Many Canadians, including ardent longtime supporters of the Geological Survey of Canada, rejected this unwelcome verdict as empty scientific theorizing, unacceptable because it appeared to cast the entire industrial future of the province in doubt.[24]

While Logan's conclusion ranked among his most far-reaching scientific achievements, his greatest achievement of all was to maintain public faith in the Geological Survey of Canada as an institution *despite* this bad news – a feat not matched by J.B. Jukes in Newfoundland, in his survey of 1838-39, or Selwyn in Victoria. Here again, it helped Logan enormously to be considered as one of the community which he served; he also recognized clearly that in order to retain public support for his survey he would have to be seen accomplishing something positive. This he did, not only by patiently discrediting every alleged coal sighting in the province, but also through a classic sleight of hand by shifting public attention outward, to the Northern Division on the fringes of the province. Logan hinted at the likelihood of finding copper and iron ores

23 This dictum is not absolutely true. In the United States, limestone occurs interbedded with coal in the 'Pennsylvanian' sequence, this later resulted in a commonly accepted terminology ('Pennsylvanian' and 'Mississipian') for what is called the Carboniferous in Europe. The 'Mississipian' is roughly equivalent to the 'Mountain Limestone,' which underlies coal-bearing successions in England, and contains many thick limestone beds. These limestones host the typical 'Mississippi' lead/zinc deposits, which are now found in many parts of the world.

24 Canada, House of Assembly, *Journals* (1844-45) Appendix W, Geological Survey of Canada, 'Report of Progress [R of P] for the Year 1843;' LP, Logan, 'Remarks' (1842); *Journals* (1846) App. GGG, R of P (1844); Zeller, *op. cit.* note 18, 57-61.

both in the Gaspé and along the upper Great Lakes, based on questionable analogies with reports of such discoveries in New Brunswick and Michigan. Such ores were indeed discovered on the shores of Lakes Superior and Huron, inspiring a rush for mining licences beginning in 1846, even though Logan knew better than to encourage heavy investment in the distant region for the time being.

Logan's slightest whisper, however, carried weight in the Montreal business community precisely because he projected the image of a scientific businessman who relied upon his own businessman's instincts to assess the commercial value of mineral deposits. He realized that until some other source of power became viable, it would remain more economical to carry copper to coal than vice versa; without a Canadian supply of coal, fiscal laws would therefore draw Lake Superior copper to the United States for processing. Still he remained openly confident that coal yet undiscovered in British territory to the northwest might one day reroute such a trade.[25]

The resistance among the Canadian public to the notion that the province lacked workable coal diminished only slowly during the second and third stages of Logan's survey, as allegations of both coal sightings and government conspiracies to conceal coal deposits continued to be levelled. For his part, Logan maintained the orthodox position that good coal could legitimately be found only in deposits of Carboniferous age, and combated public suspicion by reaffirming his impeccable scientific credentials in a larger forum. Splendid opportunities for international recognition arrived through Canada's participation in the Great Exhibition at London's Crystal Palace in 1851, and again at the Paris Exposition in 1855, where his exhibits of Canadian minerals in the context of their practical applications won Canada much favourable publicity, and Logan an induction into the Legion of Honour, a knighthood, and the Wollaston Medal of the Geological Society of London. The domestic result of these achievements was recognition by the Legislative Assembly of the Geological Survey of Canada as a permanent institution.[26]

25 *Journals* (1847), App. C, R of P (1845-46); LP, Logan to De la Beche, 12 May 1845; Zeller, *op. cit.* note 18, 59-61, 65-74.

26 Stafford, *op. cit.* note 4, 49, explains that Victorian scientists considered Carboniferous coals more valuable than younger Oolitic [Jurassic] lignites as steam fuel [as the former usually had a higher calorific value], and the resulting stratigraphic battle had important direct implications in determining patterns of colonial development. For Logan's repeated arguments regarding the Carboniferous see his Remarks (1842); R of P (1843); *Journals* (1850) App. V, R of P (1849-50); (1852) App. O and App. OOO, R of P (1850-51); (1857) App. 52, R of P (1853-54-55-56); (1858) App. 32, R of P (1857). See also Zeller, *op. cit.* note 18, chap. 4 and 95-96. Selwyn was first involved in such a problem during his time in the British Survey, working in Staffordshire with Jukes. (Branagan, *op. cit.* note 9, 1990, 144).

Logan built the final stage of his survey upon the first two. From 1857 to 1863 he assembled his cumulative report, the *Geology of Canada*, which put the coal question in the province officially to rest. Any politician who dared to question the value of the Geological Survey of Canada risked being himself perceived as an old fossil, as happened to Premier John Sandfield Macdonald in 1863. By that time Logan had purchased this irreproachable reputation at the cost of having integrated his far broader expansionist outlook thoroughly into both the functioning and public image of the survey. The geological map of the province that he produced for the Paris Exposition followed Lyell's advice of years earlier by embracing much of the rest of British North America in its scope. Logan assumed that for the sake of context and continuity such a map would have to include at least contiguous geological formations, but he wished moreover to include broader regional work on the geology of all the maritime colonies as equally important to an accurate depiction of Canada's true 'geological relations.' In this same uniformitarian vein, by the time of Confederation in 1867 Logan had extended the Geological Survey of Canada, still a provincial institution, unofficially to Newfoundland (since 1864), and was negotiating to move into Nova Scotia free of charge, as well as informally guiding the geological survey of New Brunswick.[27]

4. *Logan's Legacy to Selwyn*

When Logan left the GSC in 1869, he left a provincial institution singularly unprepared to take on the enormous task of a transcontinental survey, despite Selwyn's proven track record for covering large territories in considerable detail. Given the realities of its limited staff and its own history of constant struggle to survive financially, the survey simply could not live up to the expansionist expectations that Logan himself had helped to ignite as a means of ensuring that very survival. The result of Confederation was, for the Geological Survey of Canada, an embarrassment of territorial riches which thus removed one of the survey's best means of deflecting public disappointment in its results and criticism of its methods.

Selwyn was faced with the task not only of defending some of the earlier scientific work of the Survey (including Logan's classification of the controversial Quebec Group), but also of expanding the institution to cope on new levels of expectation as the Geological Survey was drawn into the expanding federal civil service. The enormous new political, administrative and geological framework of the Survey included the dimension of natural history that was added to its jurisdiction by the politicians in 1877.

Selwyn's approach in the face of these complex demands probably could not but appear short-sighted and narrow, and his resistance to the stresses and

27 Zeller, *op. cit.* note 18, 90, 108-9.

strains upon the institution is often evident in the Directors' Letterbooks of the Geological Survey. That the best decisions were not always made by either the politicians or the scientists, including Selwyn, during this difficult period of transition is perhaps to be expected. Yet, compounding these normal difficulties the expansionist premises that had served Logan so well continued to preoccupy both Canadian politicians and the Canadian public until after the First World War. Whenever Selwyn appeared to prefer other priorities, it was shamelessly easy to dismiss him as a mere foreigner who failed to share in the expansionist national dream. Selwyn's future biographer will have to take this ideological reality into account before the historical significance of Selwyn's career can be fully understood and appreciated, and before we jump to the hasty conclusion that Logan's personal choice of successor, like that of De la Beche before him in Britain, should best have been overruled.[28] In the Canadian case, unlike the British, such a decision would have little to do with science, and much more to do with competing ideological perceptions.

– II –
Alfred R.C. Selwyn: Her Majesty's Geological Workman on Three Continents

1. *Selwyn and the British Geological Survey*

Born twenty-six years after William Logan, at Kilmington, Somerset, Alfred Selwyn came from a social background of Church, Navy and Army, in which commerce played a very minor role. On his mother's side he was related to Alexander Murray, assistant to Logan in Canada from his appointment in 1842. Selwyn received much of his early education at home with private tutors, spent some time at school in Switzerland, where his interest in geology was aroused by taking up fossil-collecting as a hobby. He also gained some skills and enthusiasm for mountaineering while there.[29]

A few months as trainee in a bank were enough to persuade Selwyn that a career should be sought elsewhere, and in April 1845, possibly through his relative Sir George Murray,[30] he joined the Geological Survey of Great Britain, at a time when it was being restructured. After some months tuition at the Survey's London offices, including some time in the classes of the Museum of Practical

28 See esp. W.A. Waiser, *The Field Naturalist: John Macoun, the Geological Survey and Natural Science* (Toronto: University of Toronto Press, 1989): on De la Beche's successor in the Geological Survey of Great Britain, see Stafford, *op. cit.* note 4, 24.

29 Ami, *op. cit.* note 9, 173-205; Branagan and Townley, *op. cit.* note 9, 102-103.

30 Murray (1772-1846) had been involved in the appointments of both Logan and Alexander Murray in Canada several years before. Murray was well-known for his lavish patronage. The Australian Dictionary comments that through his influence the Australian colonies 'gained some third-rate public servants and many first-class settlers with capital.' (A.D.B. vol. 2, 271, unsigned).

Geology, Selwyn spent the next six years working mainly in North Wales and the adjoining counties of England, studying Lower Palaeozoic sequences (altered sedimentary and volcanic rocks), coal-bearing successions, and, incidentally, the landscape. The major influences were the two friends he worked with, Andrew Ramsay and Joseph Beete Jukes. Although the work was primarily stratigraphic, the 'practical' aspects of the Survey's work were kept in mind, and Selwyn examined iron mines, other metallic deposits, and slate quarries during his fieldwork.[31] Selwyn's work received high praise from Ramsay and later from Archibald Geikie.[32]

Impending marriage to a dowry-less cousin seems to have been the major reason for Selwyn's move to Victoria in 1852, but he must also have been influenced by Jukes's promotion to Ireland late in 1850. Full of vigour and enthusiasm Selwyn too was ready to move to a more responsible position.[33]

2. *Selwyn in Victoria*

Following massive gold rushes in Victoria Governor La Trobe wrote to the Colonial Secretary, Earl Gray, in October 1851, seeking a mineral surveyor. De la Beche recommended Selwyn, and on 25 May 1852, he was offered the post at a yearly salary of £500 and there was little delay in accepting.[34] Arrived in Melbourne in November 1852 Selwyn set up his office at Brighton, several miles from the city centre, perhaps a deliberate attempt to keep relatively out of reach of the government bureaucracy and to get on with what Selwyn regarded as his main task, a scientific appraisal of the colony's geology. Although this was a sensible practical move, it may have been a mistake for which Selwyn would pay in the long run.[35] Coupled with his long absences in

31 This aspect of Selwyn's early work has been generally forgotten, but it followed the practical principles espoused by Sir Henry De la Beche when the Geological Survey was established. It is documented in Selwyn's letters to Ramsay (Imperial College Archives, Ramsay Papers).

32 Ramsay referred to Selwyn's mapping as 'the perfection of beauty,' while Archibald Geikie, *Memoir of Sir Andrew Crombie Ramsay* (London: Macmillan, 1894), 397, later commented 'the geological structure is portrayed by Ramsay and Selwyn with a boldness and vigour, and at the same time with an artistic feeling, which had hardly been equalled in section drawing.'

33 Branagan, *op. cit.* note 9, 143-157. T.A. Darragh, 'The Geological Survey of Victoria under Alfred Selwyn, 1852-1868,' *Historical Records of Australian Science*, 7 (1), (1987), 1-25.

34 La Trobe requested 'a gentleman possessed of the requisite qualification and acquaintance with geological science and phenomena' – being 'greatly embarrassed at this time for the want of the services of a competent agent of this class.' Shortly after arriving in Melbourne Selwyn's salary was increased to £900 – an inducement not to abandon his post and join the prospectors on the goldfields, as so many public servants had done.

35 When the Survey was enlarged in 1855 Selwyn then moved into Government offices in the city.

the field, it meant that the geologist remained only a name to politicians and those responsible for funding the survey, and he would come to be judged only on the basis of his periodic reports.[36]

It should be remembered that while employed by the British Survey, Selwyn had only really been on the end of the bureaucratic ladder, receiving instructions rather than giving them. He had even been chided for taking unauthorised leave to propose to his intended wife, and had complained to Ramsay about the constant requests for receipts in relation to some unorthodox travel and accommodation on behalf of the Survey. Clearly his was not a clerical spirit.[37]

Selwyn got to work quickly, touring the goldfields region north-west of Melbourne, between 20 December and 12 January 1853. Between April and November the same year, he carried out systematic mapping of the Mount Alexander (Castlemaine) goldfield using the techniques and principles he had followed in the British Survey,[38] identifying structural features in the folded rocks, which he believed were the equivalent of the Cambrian or Lower Silurian of Britain. Economic matters were not ignored and he noted the occurrences of gold and galena and 'other minerals in minute quantities.'[39]

Selwyn's work apparently was satisfactory to the Government, and in June 1855 a formal Geological Survey was established and soon gained world-wide recognition for the quality of its work. Selwyn's second major survey – of the Yarra region immediately adjacent to Melbourne – was completed in July 1856, prompting the appointment of additional assistants. Richard Daintree,[40] C.D. Aplin, N.Taylor, G.H. Ulrich and C.S. Wilkinson were early appointees, while H.Y.L. Brown joined in 1865.[41]

36 Darragh, *op. cit.* note 32, 8-9, 13.

37 Ramsay Papers, Imperial College Archives, Selwyn letters to Ramsay.

38 Geological Survey of Victoria Library. A.R.C. Selwyn, Field notes, December 1852–January 1853, Reconnaissance Examination of Goldfields, 1853.

39 Geological Survey of Victoria Library. A.R.C. Selwyn, 'Sketch of the Geological Features of Mount Alexander and the adjacent country between the Rivers Loddon and Campaspe,' manuscript copy, 29 September 1853 (with later amendments and addenda by Selwyn).

40 In February 1854, Richard Daintree, became Selwyn's assistant, an appointment that was the beginning of an important career for Australian geology. They spent five months of 1854 mapping some 1000 square miles southeast of Melbourne, where there had been rumours of coal, amongst other useful substances. Daintree resigned in December 1855, returning to England to study at the Royal School of Mines, but rejoined the Victorian Survey in January 1859. G. C. Bolton, 'Daintree, Richard' in D. Pike (ed.), *Australian Dictionary of Biography*, 4 (1851-1890), (1972), 1- 2.

41 In 1856, C.D.Aplin and N. Taylor were appointed, followed by G. H. Ulrich in 1858 and C. S. Wilkinson in 1859. Later appointments included R.A.F. Murray, E.J. Dunn, H.Y.L. Brown, R. Etheridge Jnr, E.F. Pittman, C.S. Wood, J.C. Newbery and D.J. Mahony, 'Biographical Sketch of the Founders of the Geological Survey of Victoria,'' *Bulletin Geological Survey of Victoria*, 23, (1910,) 48; Darragh *op. cit.* note 32.

Before 1868, Selwyn's Victorian Survey produced a total of sixty-five published quarter sheets (each 9x6 miles) at a scale of two inches to the mile, the topographic mapping being also undertaken by the geologists. That Selwyn continued to make a personal contribution to the mapping of the colony can be seen from the published reports of the survey and from the summary he prepared in conjunction with Ulrich in 1866. By the conclusion of his time in Victoria Selwyn had visited almost all the colony, 88 000 sq. miles, including the very rugged country in the east,[42] building up an extensive practical knowledge of the colony (later a State), unequalled by later government geologists, despite their greatly improved facilities for travel.

The general configuration of the geology of Victoria is very different from that of Canada. Broadly speaking it consists of highly folded Palaeozoic rocks, extending from the mountainous northeast to the hilly far west, overlain by generally undeformed late Mesozoic and Tertiary sedimentary rocks along the southern coastline, and in the northwest; and two sequences of Tertiary volcanic rocks, mainly on the plains west of Melbourne. By 1863, Selwyn and his assistants had correctly determined the main framework of the geology of the colony, and had in fact gone much further in recognising subdivisions, major fault zones and other aspects of the geological history. Selwyn's high quality mapping resulted in the systematic building up of a consistent stratigraphy and geological history in the colony, forming the basis for geological work in other parts of Australia for many years to come.

However, there were problems about coal and about some curious gravels that needed resolving. Interestingly enough when Selwyn later commented on what he believed were his significant geological achievements in Victoria he included proving the extent of the gold-bearing deep leads beneath the basalts, and prediction that the gold-bearing reefs in the folded Palaeozoic rocks would continue to depth, both extremely important economic matters.[43]

In 1863, Selwyn held the title 'Government Geologist and Director of Mining and Geological Surveys,' and took the mining part of his jurisdiction seriously. Because his relatively small team of geologists was engaged in the essential work of quarter sheet mapping to establish the framework within which economic deposits occurred, Selwyn had to hire additional people to undertake detailed mine mapping, particularly in the Ballarat and Bendigo areas. One such was John Phillips, a civil engineer from Cornwall, who produced in 1858

42 Selwyn and Taylor were the first Europeans into unmapped country east of the Snowy River in 1865. Branagan *op. cit.* note 9, 147.

43 A.R.C. Selwyn, 'On the origin and evolution of Archaean rocks, with remarks and opinions on other geological subjects; being the result of personal work in both hemispheres from 1845 to 1895, 'Transactions *of the Royal Society of Canada*, second series, II, Proceedings, (1896), 1-22; W. Baragwanath, 'The Geological Survey,' *Mining and Geological Journal of Victoria*, 1 (1), (1952), 4 - 12.

the first detailed map of the deep leads of Ballarat. There is no doubt that Phillips was a competent mapper, especially underground, as his work at St. Arnaud, in western Victoria shows, but his broader interpretations of geology were not always so sound.[44]

Selwyn's remark on significant work, noted above, indicates that he was personally involved in tracing the ancient rivers containing gold, first encountered in the East Ballarat area, but then covered further west by a variable thickness of basalt. Shafts sunk through the basalt produced very large quantities of gold. However, Selwyn seems not to have made any political capital at the time out of this important economic success. Likewise, the discovery of the Caledonian Goldfield, attributed to Selwyn by Baragwanath, was not used to his advantage.[45] Selwyn's reply to the idea, strongly promulgated by Professor McCoy, that the Victorian gold ore bodies would not continue to any significant depth, was typically low key. He wrote a report for Governor Sir Henry Barkly in 1858 refuting McCoy's opinion, and to several mine managers who enquired about his opinion, but he relied largely on his reputation as a practical scientist to carry the day.[46]

By contrast with Logan, whose expansionist attitudes in Canada have been documented by one of us (Zeller), Selwyn seems to have been content to sort out the geology of Victoria, an area large enough for any single geologist's lifetime. Although he was interested in the adjacent colonies, and examined two of them, this was only at the invitation of their governing bodies, which guarded their territories rather jealously, so an areal expansion of the type Logan undertook was virtually impossible for a government-employed geologist in Victoria.

44 Phillips has been confused with his namesake J.A. Phillips who also published on Australian goldfields [see R. Etheridge and R.L. Jack, *Catalogue of reports, papers... on the geology...of the Australian Continent and Tasmania* (London: Stanford, 1881)]. His life on the Australian goldfields deserves careful study.

45 The map of the Ballarat deep leads is attributed to Phillips, and only authorised by Selwyn. Darragh *(op. cit.* note 32, 5, 20) indicates that the work was completely independent of Selwyn, but Selwyn's comment and Baragwanath (*op. cit.* note 42) suggest otherwise. Selwyn probably expected the Caledonian discovery to speak for itself [see *Dicker's Mining Record*, 1 (5), (1862), 14.

46 Professor Frederick McCoy's idea of the shallow nature of the vein gold was picked up from Sir Roderick Murchison, then Director of the Geological Survey of Great Britain, and despite McCoy's lack of field work influenced many people in the 1850-60s, although many mining authorities rejected the notion. McCoy published his opinion in a report of the Mining Commission without consulting Selwyn, who then wrote his reply. (See Darragh, *op. cit.* note 32, 4). See also A.R.C. Selwyn, Letter to R.H.Bland, 9 February 1858, reprinted in R.H. Bland, *History of the Port Phillip and Colonial Gold Mining Company* (Ballarat: F.W. Niven, 1890), 4-5.

Furthermore, avoiding the incipient nationalism that flared in Canada during the 1850s and 1860s – perhaps owing in part to the proximity of the powerful United States – the Australian colonies retained independent trade barriers and a strong sense of inter-colonial rivalry. The idea of a continent-wide nation remained the vision of a few until the 1870s, when there developed an 'increasing awareness of Australian art, literature and political debate,' more particularly among country residents than in the dwellers of the 'fiercely jealous capital cities.'[47] An example of this was the ill-fated Burke and Wills Expedition across Australia, which was sent through the efforts of the Royal Society of Victoria, rejecting the suggestion that the expedition be led by Major Warburton, an experienced South Australian, in favour of a Victorian resident.[48]

This isolationist colonial attitude affected the production of the first geological map of Australia in 1873 by Robert Brough Smyth, Selwyn's 'successor' in Victoria. Smyth contacted appropriate Government ministers in each of the colonies and ask for the latest information, which he compiled on to a base map provided by the Surveyor-General of Victoria. While most colonies were moderately helpful, the adjacent colony, New South Wales, was not at all so, and Smyth had to make do with what he could obtain from the literature. However, there were geological reasons for the lack of co-operation. New South Wales at that time had no Government Geologist, and the aging Rev. W.B. Clarke was spokesman for geological matters. Clarke had a long-term argument with Frederick McCoy about the age of Australian coal measures, and Smyth supported McCoy on the point. Selwyn, by this time well-established in Canada, was particularly incensed at the publicity the map received, which failed to acknowledge the contribution of the Victorian Survey made under his directorship.[49]

3. *Selwyn and Coal*

During Selwyn's time in Victoria, parliamentarians and the general public were obsessed with discovering coal in the colony. Because it was abundant to the north, in the colony of New South Wales, many were convinced that it should be likewise in Victoria. On a short visit to Tasmania in 1855 for that colony's Government, Selwyn, while impressed with the potential for coal mining in some areas, and recognising the similarity of some of the Tasmanian coals to those of New South Wales, commented on the waste of money and energy spent

47 G.L. Buxton, '1870-90,' in Frank Crowley (ed.), *A New History of Australia* (Melbourne: William Heinemann, 1974), 197-200.

48 Alan Moorehead, *Cooper's Creek* (London: Hamish Hamilton, 1963), 27.

49 See T.A. Darragh, 'The first geological maps of the continent of Australia,' *Journal of the Geological Society of Australia*, 24 (5), (1977), 279-305. A.R.C. Selwyn, 'The Geological Map of Australia,' *Mining Journal*, 8 March, 1873.

on exploration while geological conditions were ignored. However, the fact that reasonable deposits occurred south of Victoria, as well as to the north, again did not impress would-be industrialists in that colony. Black coal did occur in Victoria, but Selwyn recognised its poor quality (related partly to its age, believed by McCoy to be Mesozoic) and the structural complexity of its occurrence, and complained about the money he was forced to waste on testing the deposits. Despite the scientific validity of Selwyn's position, when economic deposits were not found, some accused him of incompetence, while others virtually held him responsible for the absence of good coal.[50]

As someone who regarded himself as an Englishman, Selwyn would have been happy to see the coal Victoria needed come from the adjoining colony of New South Wales – after all, it was still part of the Empire. Although he grew to love the Australian countryside, he was always an expatriate Englishman, never a colonist nor Australian nationalist, as his protégé H.Y.L. Brown became.

4. *South Australia and Glaciation*

In 1859, Selwyn undertook a two month survey of the drier and hotter neighbouring colony of South Australia, to examine its mineral potential in a traverse of 1000 km. He predicted 'no great extent of gold-producing country will ever be discovered' and found 'no indications of coal or even the presence of carboniferous rocks,' but reported also:

> ... South Australia possesses many other great natural resources...iron ores are rich and abundant...copper and lead mines will go on steadily increasing in number and importance; so also her vineyards, and cornfields...wines may be expected to vie with the best that are grown in Europe

predictions that have been abundantly fulfilled.[51]

On the Inman River in hot and dry South Australia, Selwyn observed a 'smooth striated and grooved rock surface, presenting every indication of glacial action,' the first such evidence clearly recorded in Australia, 'reminding me of the similar markings I had so frequently observed in the mountain valleys of North Wales.'[52] Selwyn believed this phenomenon was the result of Pleistocene glaciation, and maintained this idea for many years, despite later discoveries by Daintree, Brown and others of his Survey in Victoria, which indicated that the glaciation had indeed occurred in late Palaeozoic times.

50 A.R.C. Selwyn, Mineralogical Surveyor, Correspondence relating to the supposed discovery of coal. Legislative Council of Victoria, 7 September 1853.

51 A.R.C. Selwyn, Preliminary report of a geological survey of portions of South Australia, 1 July 1859. House of Assembly Papers, South Australia, 1859, No. 119.

52 A.R.C. Selwyn, Geological notes of a journey in South Australia from Cape Jervis to Mount Serle, 19 December 1859. Parliamentary Papers, South Australia, 1860, No. 20.

This argument about glaciation was partly the cause of Selwyn delaying the publication of a report by Daintree on the geology of Ballan, near Ballarat. Selwyn finally agreed to its publication, but wrote a strongly critical note in the foreword:

> though it contains a short summary of geological observations made during the survey, it can scarcely be regarded as a Geological Report of the district surveyed. The greater portion of the paper, as will be seen, is occupied with a somewhat imperfect statement of certain cosmical theories, first advanced by Sterry Hunt, on the possible relation of sedimentary deposits, generally, to upheavals and depressions of portions of the earth's crust, and their probable connection with the metamorphism and mineralisation of rock masses.[53]

In this respect, Selwyn shared the geological views of Logan.[54] The similarity of viewpoint may have been a factor in Logan's later choice of Selwyn as his successor.[55] Selwyn's first assistant in Victoria, E.J. Morgan, proved unsatisfactory, and quickly resigned, probably prompted by Selwyn, who had little patience with unsatisfactory workers.[56]

Apart from this initial 'failure,' Selwyn seems to have had the knack of choosing young men suited to his rather esoteric occupation, intellectually able and willing to put up with hard physical conditions and solitude, and even 'crusader-like' in their efforts to solve the secrets of the earth. Selwyn was successful in training staff, and while such practical matters slowed down Selwyn's mapping, it had a long term result which was of inestimable value to the development of geology in Australia.

Selwyn also encouraged his staff to gain the formal qualifications which he lacked, but which he had never had the opportunity to obtain as there was no academic course available to him in Britain. Some went to study at the Royal School of Mines, while others were already academically trained when they joined the Victorian Survey. This rapid build up of geological staff, prompted by the discovery of gold, contrasts with Logan's staff of only three in Canada – Murray, Richardson, and Sterry Hunt between 1842 and 1856.

53 Introduction by Selwyn to 'Report on the Ballan District' by R. Daintree, 7 March 1866, Victorian Geological Survey. Parliamentary Papers, Victoria (1866), 6, 11.

54 Harrington, *op. cit.* note 9, 432.

55 Perhaps Selwyn's already formed opinion of Sterry Hunt as a theorist would not have cemented relations between them when Selwyn took over as Director in Montreal in 1869. See Zaslow, *op. cit.* note 12, 98-100.

56 Contrast the tolerance Logan showed for his first chemist, E.S. De Rottermond. Zaslow, *op. cit.* note 12, 46-47.

5. *Final Years in Victoria*

Throughout his time in Victoria, Selwyn continued to lead by example, spending as much time in the field as his growing administrative duties permitted. In this respect he was more successful than Logan, who in his later years managed little time in the field. But of course he was then much older than was Selwyn in Victoria. Over the years, particularly from 1860 onwards, Selwyn had clashed with Victoria's ambitious Secretary of Mines, Robert Brough Smyth, who, although disliked by many of his employees, had the ear of influential politicians. Smyth worked hard to undermine the independence of the Survey, and have it brought within the Department of Mines. In 1862, a Board of Enquiry was set up to investigate the activities of the Department, and Brough Smyth used the opportunity, unsuccessfully, to attack Selwyn and the Survey. When Robert Bell managed to instigate a similar enquiry in 1884 into the operations of the Canadian Survey, and Selwyn's Directorship, he obtained details of the Victorian Enquiry, hoping to use it against Selwyn, a matter in which Bell was singularly unsuccessful.[57]

Changes of government and restrictions in funding began to affect the Victorian Survey severely in 1867, putting Selwyn under pressure to split the colony into zones under particular geologists, rather than continue systematic mapping. He protested repeatedly, pointing out that former governor La Trobe, on his return to England had found that Selwyn's methods were generally agreed to be best. However threats of further restrictions in funding forced him reluctantly to agree to setting up of three parties to cover different sections of the Colony – in particular, Gippsland, which many were convinced had the best coal and other mineral potential. Selwyn pointed out that he could not set up more camps without employing more geologists. However, unlike Logan, Selwyn was not politically skilled and failed to use politicians who respected his work to ensure the continuation of the Survey. His requests for increased staffing were consequently ignored.

In his refusal to play a political role, Selwyn suffered a common fate. He devoted himself to his science, believing that the quality of the work would convince anyone of its value. However, although the geological maps were highly praised and used by district engineers and surveyors, they did not become widely known among ordinary miners. The absence of detailed explanatory notes, which could have made them more understandable, limited their use to those with some theoretical knowledge of geology. The magnificent geological map of the whole colony (1863), although regarded by Selwyn as of little practical value, laid the framework for all future geological work in Victoria (and indeed the rest of eastern Australia). But the maps, together with the various published reports of the Survey, were not widely promoted, except

57 Darragh, *op. cit.* note 32, 8-9; Zaslow, *op. cit.* note 12,136; Robert Bell Papers, vol. 27, Public Archives of Canada, Ottawa.

amongst the international geological confraternity, with whom Selwyn kept in touch. So when the Survey was terminated at the end of 1868 only a few informed voices in Australia were raised in protest.[58] Late in 1868 Parliament, on the alleged grounds of economy, refused to fund the Survey, and Selwyn had no recourse than resignation.[59]

During his Australian career, Selwyn had played a major role in official scientific and mining circles, including service on the Board of Science, the Prospecting Board, and the Board of Agriculture Farm Committee, but his work as Commissioner for the International Exhibitions – at Melbourne in 1861, London in 1862, Dublin in 1865, and Paris 1866 – was arguably more important. One of his tasks was to arrange for collections of the colony's mineral products to be displayed, and to prepare explanatory notes to accompany them. In this way, the Survey's work reached a wide audience, both in Victoria and abroad. The valuable collections themselves constituted the basis for important museum collections in Melbourne and rural Victorian towns, as well as in London and other European centres.[60]

Selwyn recognised the educational value of such displays, as helping to fill the gap in Victorian mining circles occasioned by the absence of local mining schools. Such educational facilities were sorely needed. As William Howitt noted in 1854, the required qualifications for the Gold Commissioners at Bendigo appeared to be those of 'being able to wear a gold-laced cap and coat, to ride a horse, to be able to smoke a cigar, gamble, drink a tolerable share of wine, and patronise horse-racing.'[61] The Government made some moves towards improving this situation early in 1856, forming a Mining Board and establishing a mining museum. There were also sporadic moves in Victoria to set up formal training in mining, and Selwyn was one of the examiners on the Board of Science which replaced the Mining Board in 1858. Selwyn certainly approved of the idea of such training, but it was not until 1871, several years after his departure from Australia, that the first Victorian School of Mines was established at Ballarat.[62]

58 Darragh, *op. cit.* note 32, 14-15.

59 Brough Smyth had a hand in the closure of the Survey, but his later attempt to take the place of Selwyn in the colony's activities was less than successful. Darragh, *op. cit.* note 32, 15-16; M.E. Hoare, ' 'The half-mad Bureaucrat': Robert Brough Smyth (1830-1889),' *Records of the Australian Academy of Science*, 2 (4), (1974), 25-40.

60 D.F. Branagan, 'Early European Mineral Collections and Collectors in Australia,' Abstracts *Seminar '91 of the Mineralogical Societies of New South Wales, Victoria, South Australia and Queensland*, 1991, 10-11.

61 William Howitt, *Land, Labour and Gold* (London: Longmans, Brown and Longmans, 1855), 231.

62 Adrian R. Haas, 'Schools of Mines in Australia, 1870-1920,' *Journal of the Royal Australian Historical Society*, 75 (4), March 1990, 275-294 gives a good outline of the movement, but his rather negative view of their success is not completely justified.

6. *Selwyn and Canada*

Selwyn and his family left Australia for England in March 1869. Although sad to leave Victoria, Selwyn announced that he had already accepted an offer to take charge of the Geological Survey of Canada (GSC).[63] By October, he was in Montreal, and by December, had assumed the post of director.

Logan's territory had been large – some 300 000 square miles of the eastern half of what is now Canada – and he had mapped, with a small staff, about half of this complex territory by 1869. Selwyn's task was to be much greater both in complexity and areal extent with the annexing of the North-West Territories and the western Cordillera in 1868-70. This new Canada was an area close to 4, 000, 000 square miles. As in Victoria, Selwyn made himself acquainted with his enormous bailiwick, travelling first to the Eastern Townships, New Brunswick and Nova Scotia to examine the goldfields and compare them with those of Victoria. This knowledge of the geology and waterways of the better studied parts of Canada were followed over the next three years by long expeditions in the newly acquired western regions. He continued to undertake fieldwork every summer. Although as he approached his seventies he found it increasingly arduous, it gave him the background to speak authoritatively about the geology of Canada, and to support his staff in stratigraphical arguments with geologists from the United States.[64]

In Canada, Selwyn continued staff policies he had used in Australia, although he complained that he was unable to sack the incompetent or lazy. As early as 1871 Selwyn moved 'to give the preference to young men who have received an education specially fitting them for the work, and who wish to make it their profession.'[65] Selwyn turned to the universities and Canadian colleges for his recruits. Many of these institutes had a more practical approach to education than their British counterparts, although there was at the time no exact North American equivalent of the Royal School of Mines or the mining schools at Freiberg or Clausthal in Germany, or the École des Mines in France. By the 1880s, Selwyn had established not only the attitude, but the written rule, that only graduates would be employed as geologists in the GSC. He also expanded the expertise, employing civil engineers and mining geologists, the former particularly for topographical surveying. Selwyn's policy on employment encouraged the development of geology as a discipline for study in the emerging Canadian universities, and, as in Australia, can be said to have launched geology as a profession in Canada.

Although elected an FRS in 1876, and receiving the Murchison Medal of the Geological Society of London, his service to Canada, particularly at various

63 Darragh, *op. cit.* note 32, 13-14.

64 Branagan, *op. cit.* (1990), note 9, 151-153; Zaslow, *op. cit.* note 12, 119.

65 Quoted by Zaslow, *op. cit.* note 12, 131.

international exhibitions, never received the acknowledgment accorded Logan, Selwyn was awarded a C.M.G. after the Colonial and Indian Exhibition in 1886, but never a knighthood.[66] In his history of the Survey, Morris Zaslow has discussed some of the geological, organisational and political facets of Selwyn's twenty-six years as Director of the Canadian Survey, but there is much work still to be done.[67] However, William C. Peters observes that the expansion of the Canadian Survey's 'territory,' under Selwyn, with its 'series of epic reconnaissance traverses' produced

> geologic maps with comments on mineral deposits, [which] became immediate guidelines to prospecting. A successful Canadian formula for co-operative effort between government scientists and private prospectors began to take shape, and the shape became so attractive that it was closely copied by geological surveys throughout the world.

Selwyn undoubtedly bred success in the very field of endeavour, support for mining, that many accused him of neglecting.[68] After his enforced retirement in January 1895, Selwyn moved to Vancouver, where, ironically enough, he advised and consulted on mining in the western region. He died in Vancouver on 18 October 1902.[69]

7. *Selwyn in Summary*

Selwyn's seven years (1845-1852) in the Geological Survey of Great Britain, and his association with Andrew Ramsay and Joseph Beete Jukes in mapping the rocks of Wales, were an excellent preparation for his geological work in Victoria. In England he learned the physical characteristics of regionally-metamorphosed Lower Palaeozoic rocks, became familiar with coal measures, and gained an insight into aspects of glaciated landscapes. He appreciated tried methods of field mapping and presentation of geological data on maps and sections. He was to be frustrated in his later work principally because the limited topographic maps available to him in Victoria and Canada prevented his obtaining the accuracy in geological mapping he desired. Nonetheless, during his seventeen years in Victoria (1852-1868), Selwyn laid the foundations for the geological profession in Australia. Selwyn had the gifts of a

66 For this exhibition Selwyn and his staff assembled a large display of the economic minerals of Canada, together with a descriptive catalogue. *Colonial and Indian Exhibition, Descriptive Catalogue of a collection of the Economic minerals of Canada by the Geological Corps Alfred R.C. Selwyn, Director*, (London: Alabaster, Passmore & Sons, 1886), 172.

67 Selwyn's involvement in some interesting geological controversies has been touched on by Branagan, *op. cit.* note 9, 153.

68 William C. Peters, *Exploration and Mining Geology* (New York: John Wiley, 2nd ed. 1978), 6.

69 Selwyn's obituary, *The Province* (Vancouver), 20 October 1902.

teacher, albeit a hard taskmaster, and it was by his example and instruction that he trained a number of talented young men in the Geological Survey of Victoria, and encouraged others to study at the Royal School of Mines. In Canada, he pursued the same high standards, and ensured a continuance of professional standards amongst geologists.

In his early fieldwork days, Selwyn had a cheerful disposition, but in later years he became taciturn in his official dealings and known for his quick temper. No 'political' cartoons satirised him; Selwyn was not someone one might joke about. In Canada, Selwyn remains overshadowed by the memory of Logan, but there are signs that his contribution is now being recognised. He certainly had the respect of his staff, and is commemorated by landmarks in both Australia and Canada.[70] While there were other important pioneers in Australian and Canadian geology, Selwyn's presence marked the beginning of a professionalism which passed down through his network of colleagues and which continues today.

– III –
Henry Yorke Lyell Brown

1. *A Canadian Beginning*

Henry Yorke Lyell Brown, the son of Richard Brown, F.G.S. (1805-82), mining engineer and geologist, was born at Sydney, Nova Scotia, on 23 August 1844, not long after William Logan had completed his first report on the geology of the coal measures there. Brown's father, at one time General Manager of the Mining Association of London, was then managing the Sydney coal mines. During the first visit by Charles Lyell to Canada in 1842, Richard Brown had spent some time showing Lyell the geology of the Sydney coalfield, and being impressed by the contact, had honoured his visitor when naming his son.[71]

Henry grew up in an environment in which geology was part of life, and it was no surprise therefore, that, after studying and briefly teaching at Kings College, Windsor, N.S , he went to the Royal School of Mines in London. The family influence was strong, for his older brother Charles Barrington also became a geologist, and recognised particularly for his work in South America, although he was later briefly in Australia. Henry Brown spent 1863-64 at the RSM hearing the lectures of Andrew Ramsay, T.H.Huxley, John Tyndall, Warington W.Smyth, Robert Etheridge Snr., John Percy and A.W. von Hofmann – a formidable team, and all colleagues of A.R.C. Selwyn ten to fifteen years

70 For Selwyn's skills in writing and editing, see W.J. Loudon, *A Canadian Geologist* (Toronto: Macmillan, 1930), 257. The Victorian Division of the Geological Society of Australia now pays tribute to his memory with a biennial Lecture.

71 Charles Lyell, *Travels in North America* (London: John Murray, 1845), vol. 2, 200. Richard published several books on the history and geology of Nova Scotia. Henry's older brother was Charles Barrington Brown (1839-1917).

previously. On Ramsay's recommendation Brown was invited to join Selwyn's Geological Survey of Victoria, in 1865. He worked mainly in the north of the colony till the survey was disbanded at the end of 1868.

2. *Colonial Experiences*

Unlike Logan and Selwyn, Brown held a succession of relatively short appointments during the next phase of his career. A brief period as Goldfields Surveyor on the Coromandel Peninsula in New Zealand was followed by his appointment as Government Geologist of Western Australia in 1870 until 1872. Financial difficulties seem to have been the major reason for his leaving that appointment, as the Governor, Frederick Weld, was himself a keen amateur geologist, and wished to see the work continue. But some members of the Legislative Council felt Brown did little but ride around the country putting meaningless marks on maps and bringing back loads of rocks for the colony's fledgling museum at Fremantle. Brown went back into the mining fields of Victoria and New Zealand for the next two years – a period which gave him a further insight into the practical difficulties and the economics of mining, something which proved very useful to him in later years.

In 1874, he returned to Canada, where Selwyn was happy to employ him again. But Brown had grown to like the climate of Australia and eighteen months was enough for him in his homeland.[72] In 1875, he resigned to return to Australia, this time working in the mining fields of Victoria and New South Wales before a permanent position was offered him on the Geological Survey of New South Wales, in May 1881.[73] However, in South Australia there were moves afoot to follow up the brief surveys done by Selwyn in 1859 and G.H. Ulrich in 1872. Although no official advertisement appeared, Brown was approached and was appointed on 1 December 1882 at a salary twice what he had received in New South Wales. Apart from a period between July 1883–May 1886 and again in 1910, Brown was to be essentially the sole geologist of the South Australian Survey from 1882 to 1911.[74]

3. *A Solo Role in South Australia*

When Brown was appointed, South Australia comprised the whole of central Australia (including present-day South Australia and the Northern Territory), and even when the Territory came under Federal jurisdiction in 1901 Brown was asked to continue his work there. At the time, South Australia had fewer

72 Robert Bell tried to use Brown's departure from the Canadian survey as an attack on Selwyn. Public Archives of Canada. Bell's evidence to Select Committee on [Canadian] Geological Survey, (1884), 82.

73 Dunn and Mahony, *op. cit.* note 40, 43.

74 O'Neil, *op. cit.* note 9, 359.

railways and roads than Victoria. Most of the colony was arid and virtually uninhabited either by Aborigines or Europeans. The combined area of South Australia and Northern Territory is 2.3 million sq. kms. In his twenty-eight years, Brown covered almost all of this enormous region, a feat probably unparalleled in the geological profession.

From the beginning, Brown was dogged by political and bureaucratic orders to investigate every optimistically advertised mineral show, every request for underground water, so there was little chance to initiate a consistent program of geological mapping as Selwyn had begun in Victoria. In addition to his geological responsibilities, Brown also acted as Inspector of Mines and despite these demands on his time, proved astute in gathering and synthesising geological data during forced rushes from one site to another. As early as December 1883, he was able to produce a basic geological map of South Australia at a scale of 1 inch = 16 miles (revised December 1886). In 1898 he produced a map of the Northern Territory at a scale of 1 inch = 20 miles. In 1884, Brown followed Selwyn's lead in mapping by having a Topographical Survey set up under the aegis of the Geological Department. but it was terminated in May 1886, at the same time as he lost his assistant.

Brown's mapping covered vast areas of Precambrian rocks, and took in wide regions of Tertiary and younger desert sediments. As for Selwyn, coal proved a bugbear for Brown, as relatively poor quality Tertiary lignite deposits alone were available in South Australia. At one stage, desperate bureaucrats sent Brown to New South Wales to buy a black coal mine for the colony, but when negotiations were almost complete, the colonial legislature turned face and voted the matter down. Present day analysts attest to the remarkable accuracy of Brown's detailed observations, and the perceptiveness of his broad interpretations, the framework he established in his published maps having stood the test of time.

Brown was never one for words and his reports are notably terse and factual. He was always cautious in his reports of mineral prospects, and criticised the public for speculating on the stock exchange before mines were 'fully examined, prospected and scientifically proven,' an attitude he would have shared with Selwyn, and no doubt also with his father. Observing that '...the present age demands a more intelligent class of mine captains, engineers and miners, and the establishment of schools of mines becomes every year more necessary and the time has passed for mines to be managed by rule of thumb,'[75] he helped establish a School of Mines in Adelaide in 1889, and secured the appointment of an Inspector of Mines. This freed Brown for geological work and collecting. Like Selwyn, he prepared displays for major exhibitions, and just as Selwyn's

75 H.Y.L. Brown, *Records of the Mines of South Australia* (Adelaide: Government Printer, lst ed. 1887); O'Neil, *op. cit.* note 9, 77.

Victorian and Canadian material, Brown's specimens became valued parts of major collections both in Australia and abroad.[76]

During twelve months leave in 1899, Brown renewed his Canadian and European links, but essentially a loner he returned happily to his desert surroundings. At the age of sixty-seven, he married. He resigned early the following year (1912), although he continued to advise the Department of Mines until his death in 1928.

4. *Selwyn and Brown – Similarities and contrasts*

Despite many differences in their fields of operation, there are striking parallels between the kind of work Selwyn's and Brown undertook. Both served governments for the most of their lives. Both enjoyed fieldwork and long journeys under arduous conditions. Both stressed professionalism as essential for the progress of geology and mining. Brown had qualifications from the RSM, but Selwyn had not, rather 'graduating' by training under Ramsay and De la Beche in a period when the School of Mines was in gestation. A foundation member of the Royal Society of Canada (1882), Selwyn summed up his views about geology in his Presidential address to the Society in 1896. As a 'geological workman on behalf of Her Majesty' for some fifty years he deplored the 'somewhat vague, erratic sometimes contradictory manner in which geological writers use certain terms' ....which 'scarcely tend to enlighten the geologist, much less the ordinary reader.' Instead he claimed, 'being conscious of my lack of oratorical or scriptorial qualifications, I have rarely been induced either to talk or to write for publication....the result was that I had more time for observation, by which I certainly gained and probably no one else lost anything...'. Selwyn's apt quotations from Goethe, Shakespeare and Tennyson give the lie to his professed lack of Literary culture.[77] Selwyn summarised his philosophy thus: 'in seeking truth, which should be the only aim of science, authority, orthodoxy, jealousy, partisanship, expediency, power, profit, pay and feelings should be rigidly excluded. Such considerations belong to the arena of politics and pink pills. They are legitimate in political and mercantile matters, but are quite out of place and unworthy when introduced into the domain of science.'[78]

Both Selwyn and Brown believed in the value of museums as places of practical instruction and research. In this regard, Selwyn was more fortunate and successful, in that the relatively prosperous conditions in Victoria during the 1850s, and his later time in Canada, gave him the necessary financial support

76 Branagan, *op. cit.* note 59. See also W. Campbell Smith and P.M. Game, *Catalogue of the rock collections in the Mineral Department of the British Museum (Natural History), III, Antarctica and Australasia* (London: British Museum, 1954), 217.

77 Selwyn, *op. cit.* note 42,3.

78 Selwyn, *ibid.*, 3-4.

to create or continue viable museums. Brown's efforts in this respect were somewhat frustrated, although he continued to collect and to encourage others to do so. The collecting carried out and encouraged by both men also formed the basis of displays mounted at various international exhibitions, which helped to publicise the mineral wealth of their countries and to encourage investment and migration.

Relative to the extensive fieldwork both undertook, their publication was slight. This was a deliberate policy of both men. Brown was always a man of few words, while Selwyn was more concerned to 'pass on information directly to those who needed it.'[79] Neither was trained for office work and both had to learn how to deal with bureaucracies. Both believing officialdom interfered with the conduct of scientific work. Brown solved this problem best by taking to the bush. Selwyn, less patient, took on the opposition with memo and argument. While their achievements were considerable, both 'undersold' themselves by refusing publicity; both believed the quality of their scientific work was sufficiently visible to gain support. Sadly for them, those who control the public purse did not, and often still do not understand the value of such work. Brown laid the basis of the geology of a vast area of Australia, which later geologists have built on. But unlike Selwyn's Brown's work was essentially individual. Selwyn's scientific work was supplemented by practical training, shaping the tradition of professional geology in Australia and Canada. Selwyn's efforts spanned three continents in a career of fifty years.

Epilogue

As an important component of Victorian culture, geological exploration in both Canada and Australia during the nineteenth century took familiar forms. Inspired by the example of the Geological Survey of Great Britain, colonial governments in both countries voted public funds to investigate the industrial and agricultural potential of their lands. Not only did the British survey help to organize and staff its colonial counterparts in Canada and Australia, but both colonial surveys were furthermore shaped by personal links in the careers of William Logan, Alfred Selwyn and Henry Brown. Yet while both colonial surveys were expanding to meet transcontinental needs by the late nineteenth and early twentieth centuries, certain aspects of their common historical context had begun to shift the ground beneath them.

First, by the 1870s the centre of attention for the geological sciences in English-speaking regions was turning away from the British Survey, under its aging director Andrew Ramsay, and his successor Archibald Geikie, to the more dynamic and better funded United States Geological Survey.[80] The late

79 Selwyn, *ibid.*, 3-4.

80 Henry Faul and Carol Faul, *It began with a Stone* (New York: John Wiley, 1983), 193-207.

nineteenth century saw the vast expansion and settlement of the North American continent, its crossing by railways, and the extraordinary success of the U.S. Geological Survey, and its state-based forerunners. The epic journeys of Clarence King, Ferdinand Hayden, and John Wesley Powell, and their shrewd use of publicity and politicians guaranteed a populace primed to spend public funds on mineral exploration and general geological mapping.[81] The American public accorded much attention to the Grand Canyon journeys, the U.S. Survey's exposé of the great diamond hoax, and the impressive volumes that resulted from the U.S. exploring expeditions. By contrast, the British Survey appeared increasingly antiquated in the light of new concepts and new technologies in the United States, Germany and elsewhere.[82]

The contrast with Canada was equally sharp. Selwyn's arduous transcontinental explorations undoubtedly matched those south of the 49th parallel. But his reports of comparable adventures were characteristically understated and even laconic in tone, and they seldom caught the attention of the Canadian public. Aside from following a few formal avenues for co-operation with his American counterparts, Selwyn remained both sentimentally and intellectually attached to the British Survey. While the Americans led the way towards a dynamic professionalism among their geological ranks, Selwyn endured the transfer of his survey to the rubric of the Canadian civil service in a difficult transition during the 1880s. Much bitterness among his staff against inequities resulting from this transition was directed towards Selwyn personally.[83]

The waning of British geological predominance relegated Australian geology to still deeper shadows, largely because of the great distances to both Europe and North America. William Logan had recognised during the 1850s that practical necessity and British lethargy were forcing the Canadian Survey to co-operate with its more accessible American counterparts. It was much easier for Canadians than for Australians to participate in either the British or the American Associations for the Advancement of Science, and even to host their meetings (they did so in 1884, 1897: and 1857, 1882 respectively).

Australian geologists waited until 1914 to host a visit of the BAAS, but meanwhile had helped to found their own Australasian Association for the

81 *Ibid.*, 200, 203.

82 Jethro Teall was the first petrologist appointed (by Archibald Geikie) to the British Survey in 1888. See David Oldroyd, *The Highlands Controversy* (Chicago: Chicago University Press, 1990), 252-253.

83 Faul, *op. cit.* note 82, 200-202. Brebner writes 'some of the most thrilling Canadian history is contained in the sober words and pioneering maps of the Geological Survey,' J. Bartlet Brebner (revised and enlarged by D.C. Masters) *Canada* (Ann Arbor: University of Michigan Press, 1970), 318. See also Zaslow, *op. cit.* note 12 and S. Zeller, 'Selwyn, Alfred Richard Cecil,' in *Dictionary of Canadian Biography*, vol. 13 (in press).

Advancement of Science in 1888.[84] Yet they, too, were strongly influenced by American geological perceptions of the formation of the landscape, especially the ideas on uplift and erosion. These ideas remained largely intact until the 1970s, when Australian geomorphologists began to re-examine the evidence and to propose alternatives involving the preservation of very ancient 'fossil' landscapes.[85] When Brown noted the special character of the 'duricrust' surfaces of much of inland Australia he foreshadowed this important change in the interpretation and understanding of the landscape.

Relatively less effort was expended on the study of geomorphology in Canada, as George Mercer Dawson and others limited their acceptance of glacial theory. In Australia, Selwyn, Brown and others uncovered in south-eastern Australia evidence of a late Palaeozoic glaciation that proved crucial to the theory of continental drift, and was later subsumed by the theory of plate tectonics. Still later work on the essentially undeformed Proterozoic rocks of northern Australia (containing evidence of another ice age), after 1950, constituted a major contribution to geological thinking.[86]

A second important change in both colonies was seen in the economic climate of the late nineteenth century. The enormous territories in both Canada and Australia that remained unmapped and unexplored called for the continuation

84 Michael Worboys, 'The British Association and Empire: Science and Social Imperialism, 1880 -1940,' in Roy MacLeod and Peter Collins (eds),*The Parliament of Science: Essays in Honour of the British Association for the Advancement of Science* (Northwood, Middlesex: Science Reviews, Ltd., 1981), 173 -176.

85 C. D. Ollier, 'Landscape Evolution in Australia,' *26th Congress of the International Geographical Union Abstracts* (Sydney, 1988), vol 2, 422.

86 D.F. Branagan, 'Putting geology on the map: Edgeworth David and the Geology of the Commonwealth of Australia,' *Historical Records of Australian Science,* 5 (2), (1981), 35. D.F. Branagan and K.A. Townley, 'The Geological Sciences in Australia – a Brief Historical Review,' *Earth Science Reviews*, 12 (1976), 339-343; Thomas Vallance and David Branagan, 'The Earth Sciences: Searching for Geological Order,' in Roy MacLeod (ed.), *The Commonwealth of Science: ANZAAS and the Scientific Enterprise in Australasia, 1888-1988* (Melbourne: Oxford University Press, 1988), 141; Faul. *op. cit.* note 79, 176 and 204-207. On Logan's Laurentian see Harrington, *op. cit.* note 9, 332-345. On G.M. Dawson, see S. Zeller and G.Avrith Wakeam, in *Dictionary of Canadian Biography,* vol. 13 (in press). On the Australian Precambrian, see H. F. King, 'History of Development of Resources of Metallic Ores,' in Alan Trengrove, *Discovery: Stories of Modern Mineral Exploration* (Mont Albert, Victoria: Stockwell Press, 1979), 251-270; David.F. Branagan 'History of concepts of Precambrian Geology in Australia,' in W.O. Kupsch and W.A.S. Sarjeant (eds), *History of Concepts in Precambrian Geology*. Geological Association of Canada Special Paper, No. 19, 1979, 13-32; George P. Merrill, *The First One Hundred Years of American Geology* (New York: Hafner, 1964), 413 and 636; Paul André Linteau, René Durocher and Jean-Claude Robert, *Quebec: A History, 1867-1929*, trans. Robert Chodos (Toronto: Lorimer, 1983), 321. See also Paul-André Linteau, René Durocher and François Rickard, *Quebec since 1930*, trans. Robert Chodos and Ellen Garmaise (Toronto: Lorimer, 1991).

of basic reconnaissance work just at a time when a longterm economic downswing seemed to call for useful mineral discoveries. Reconnaissance meant work largely on the predominant Precambrian formations, in Canada by Selwyn, G. M. Dawson and Robert Bell; and in Australia by Brown in the huge Northern Territory region, which came under Commonwealth control after Federation, as well as in South Australia. More systematic work was carried out in the twentieth century by Walter Howchin and Douglas Mawson in South Australia, and by others in Western Australia.

In a sense, the work of Logan and Selwyn in Canada did not produce tangible fruits until well after they had left the Survey. The giant of Canadian mining was stirring in the 1890s, especially with the Klondike gold rush in 1896. Even Selwyn became involved in the surge of interest in mining in British Columbia after his retirement from the Survey in 1895. The rich but structurally complex coal deposits in the folded Rockies west of Crowsnest Pass were also located during the 1890s, but were not to be worked successfully until many decades later. Large-scale mining in Ontario began only after 1900, while major mineral discoveries in Quebec occurred as part of the so-called second Industrial Revolution in the 1930s.[87] Brown's reward in Australia was likewise a long time in coming. His basic mapping became the first step in the development of mining in the Australian interior, including gas and oil fields in South Australia and the Northern Territory, and major gold, uranium and copper deposits flourished in profusion from the 1950s.

The Canadian and Australian communities in which Logan, Selwyn and Brown developed their ideas, carried out their geological surveys, and left their mining legacies offer considerable opportunity for historical comparison and contrast. Sometimes interlocking, sometimes overlapping, sometimes separate, these two communities provided variations in context that enable historians to formulate questions of cause and effect, and to test possible answers. We have mentioned in passing only a few of those who assisted these geologists, because that is a story in its own right. Nor have we compared in full their various approaches to the administration of large-scale geological surveys. We see this work as a beginning, with shades of themes to come.

87 Royal Bank of Canada, *A Conspectus of Canada, Centennial Year 1967* (Montreal: Royal Bank of Canada, 1967), 87, 123.