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J.W. Spencer (1851-1921): His Life in Missouri and Georgia, and Work on Proglacial Lakes

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Article abstract

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ARTICLES

J.W. Spencer (1851-1921): His Life in Missouri and Georgia, and Work on Proglacial Lakes

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SUMMARY

In 1882, Spencer left Canada to become Professor of Geology and Mineralogy, and Director of the Natural History Museum at the State University of Missouri. His first task was to design and equip the new museum, part of a planned extension of the main university building. The museum was completed in 1884, but funding for specimens and furnishing was withheld as feuding between the administration and the State increased. In 1886, Spencer visited Europe, making observations in Norway which strengthened his belief that glaciers were ineffective agents of erosion. Spencer was forced to resign in 1887: he devoted that summer to intensive fieldwork in the Great Lakes region, tracing proglacial lake beaches. He was appointed Professor of Geology at the State University of Georgia in Athens in 1888 and devoted that summer to further fieldwork on the proglacial beaches. The summer of 1889 was spent in geological surveys for a new railroad in Georgia and Alabama, and in 1890 Spencer gave up his position as Professor to become State Geologist of Georgia. This position ended in 1893, because Spencer had mapped mainly Paleozoic rocks in the northwest part of the State, and was intolerant of demands that he yield to political pressures and spend more time on practical matters, including gold deposits. His two seasons of fieldwork (in 1887 and 1888) were the main basis for the numerous papers that he subsequently published that named proglacial lakes (e.g., Iroquois, Algonquin), described their post-glacial deformation, and discussed their origin. Spencer did not accept that the Great Lakes region was ever covered by thick ice sheets: he believed the proglacial lakes formed at sea level, and were not the result of ice-dams.

SOMMAIRE

En 1882, Spencer a quitté le Canada pour devenir professeur de géologie et de minéralogie, et directeur du Musée d'histoire naturelle de l'Université d'État du Missouri. Son premier mandat a été de concevoir et équiper le nouveau musée, lequel devait être un prolongement de l'édifice principal. La construction du musée a été complétée en 1884, mais les fonds pour l'achat de l'ameublement et de spécimens n'ont pas été débloqués pour cause de mésentente croissante entre l'État et la direction. En 1886 Spencer a voyagé en Europe et les observations qu'il a faites en Norvège ont renforcé sa conviction que les glaciers n'étaient pas des agents d'érosion efficaces. En 1887, Spencer a été forcé de démissionner : il a consacré cet été là a d'intensifs travaux de terrain dans la région des Grands Lacs, relevant le tracé des plages proglaciaires. En 1888, il a été embauché comme professeur de géologie à l'Université d'État de Georgie à Athens, et il a consacré son été à la poursuite de ses travaux sur les plages proglaciaires. Durant l'été de 1889, il a réalisé des levés géologiques en rapport avec la construction d'une nouvelle voie ferrée en Georgie et en Alabama. En 1990, il a quitté son poste de professeur pour devenir géologue au service de l'État de Georgie. À ce poste, Spencer s'est surtout consacré à la cartographie des roches paléozoïques du nord-ouest de l'État, mais il a dû quitter ce poste parce qu'il refusait de céder aux pressions politiques voulant qu'il consacre plus de temps à des considérations plus pratiques, tel les gisements aurifères. Les informations recueillies lors de ses deux saisons de travaux de terrain (1887 et 1888) ont constitué la référence principale de nombreuses publications qui sont à l'origine des noms donnés aux lacs proglaciaires (Iroquois, Algonquin par ex.), de descriptions de leurs déformations post-glaciaires, et de discussions sur leur origine. Spencer n'acceptait pas l'idée que la région des Grands Lacs ait déjà été recouverte d'épaisses lentilles de glace : il croyait que les lacs proglaciaires avaient été formés au niveau de la mer et qu'ils n'étaient pas le résultat d'un effet de barrage créé par les glaciers.

SPENCER'S LIFE IN CANADA

J.W. Spencer, born and buried in Dundas, Ontario, was a pioneer Canadian geomorphologist. After attending school in Dundas, he moved to Hamilton where he worked in a pharmacy, and was encouraged by local

amateur geologists. He attended McGill University from 1871 to 1874, studied under William Dawson and Bernard Harrington, and graduated in the newly reorganized Applied Sciences program. He spent the summer of 1874 working as Robert Bell's assistant in Manitoba, and the following summer working in the Michigan copper mines, as an assistant to a mine engineer, Luther Emerson. He obtained a position as science teacher at Hamilton Collegiate Institute in 1876. In 1877 he submitted his thesis on Michigan copper deposits to the university at Göttingen, Germany and that summer he visited the university, passed his oral examinations and was awarded his Ph.D., thus becoming the second Canadian to earn a doctorate in geology. In 1880 he became Professor at King's College, Windsor, Nova Scotia. His geological studies concentrated on the region around his birthplace at the head of Lake Ontario: at first they were mainly of Paleozoic geology and paleontology, but by 1880 they had switched decisively to surficial geology, particularly the preglacial drainage of Lakes Erie and Ontario. In 1880 he travelled extensively in the United States and attended the American Association for the Advancement of Science meeting in Boston, where he met J.P. Lesley, who encouraged him to continue his studies of preglacial rivers.

This part of his life is described in an earlier paper (Middleton, 2004). The present paper describes his life at the universities and state surveys in Missouri and Georgia, and his continuing work on the proglacial precursors of the Great Lakes.

PROFESSOR AND MUSEUM DIRECTOR, UNIVERSITY OF MISSOURI

Museum and Teaching Duties

In the fall of 1882 Spencer left Canada to become Professor of Geology and Mineralogy, and Director of the Natural History Museum at the State University, in Columbia, Missouri (at a salary of $2000, substantially larger than anything that King's College, NS, could offer). The position had been offered first to William Dawson himself ("at any salary he would name": letter from S.S. Laws in the McGill archives of Spencer testimonials), but he declined it and suggested Spencer. The official history of the university (Stephens, 1962, p. 319) reports that Spencer "...was said to have had the best testimonials of any man employed by the University up to that time." His salary was larger than that of most of the other professors.

Though he left King's partly because of his disagreements with the President and Board, he thought he had gained valuable experience there, and later wrote (BP, May 4, 1885): "King's was an excellent school for me. It did much in educating me in executive ability."

Spencer arrived in Columbia, Missouri in September 1882. His route must have been circuitous because he claimed that he had "pass[ed] over 5500 miles of railway, spent a few days in Montreal, and packed two tons of geological specimens and books." (DP, Sept. 16, 1882). In the same letter, he wrote to Dawson: "Columbia is situated in a rolling country with a small tributary of the Missouri River passing nearly around it, through a very deep valley, like all western streams...It is not to be compared, as far as situation to Windsor [Nova Scotia] and is not more than twice as large. The weather is very warm."

In 1876, the Curators (governing board) of the University had appointed a new President, Samuel Spahr Laws, a polymath with degrees from Miami University, Ohio, and the Theological Seminary at Princeton, and experience as President of a small Presbyterian college. Imprisoned in Missouri for his Union sympathies for a few months during the Civil War, he was released on condition that he leave the country. He visited Europe, and on returning to New York City at the end of the war, he obtained further degrees in Law and in Medicine, and made a fortune by inventing the stock ticker for the New York Stock Exchange (J.H.C., 1933; Havinghurst, 1996). His enterprise and experience should have made him an ideal candidate for President, but he had one fatal flaw: he insisted on determining personally almost every detail of university operations (Stephens, 1962, Chapter 6). This characteristic was soon recognized by Spencer: he wrote (BP, March [?], 1885) to Bell: "...there is a good deal of ill-will between the Board and the President. The President is a giant of a man and is an autocrat." Spencer, who had strong Tory sympathies, generally approved of autocracy, and distrusted American-style democracy.

The University consisted of a College of Arts (including a new Science Building), a Normal School (soon downgraded by the new President), a College of Agriculture, and a well established School of Medicine. Though Laws did his best for the School of Agriculture, by the time Spencer arrived he was involved in a dispute with the Dean, who resigned in 1882. Nevertheless, that spring the legislature awarded him a grant of $100,000 to enlarge the main building of the University.

Laws was strongly interested in science: he provided $2000 out of his own funds to help finance an improved observatory and telescope, and he hired Spencer mainly in order to design and purchase specimens for a new Museum, which was to occupy one of two new wings built on the expanded University Building. Spencer also became Professor of Geology and Mineralogy, a position previously held by the former Dean of Agriculture.

As it happened, on museum matters, Spencer could turn to his mentor, William Dawson, for advice. At McGill University, Dawson had just completed the construction and outfitting of the Redpath Museum. It had been built with a bequest of $140,000 from the "sugar baron" Peter Redpath, and incorporated Dawson's own collection of 10,000 rocks and fossils (Sheets-Pyenson, 1996, p. 66–72). By the spring of 1883, Spencer had drawn up some preliminary plans for the Missouri building, which he sent to Dawson for his comments (DP, Mar. 17, 1883). The legislature had voted $100,000 to enlarge the main university building. The new west wing was to have four stories, with a library on the third floor, and the fourth devoted to "rooms for [a] geological and Natural History Museum and lecture

rooms." After further planning, the library was installed above the chapel in the east wing, and the west wing was devoted to rooms for the President, and a room and lecture room for each of the professors of geology, modern languages, and physics. The Museum occupied "...the front half of the west wing... and consists of one floor and four galleries, each 45 x 20 feet and well lighted. My lecture room is the best geological room except yours that I know of." (DP, Apr. 18, 1885)

Construction of the Museum proceeded according to plan: Spencer wrote to Bell (BP, Dec. 1, 1884): "...I have got a magnificent museum – one of the best, with excellent lecture rooms, mineralogical laboratory and work rooms." His newly minted letterhead proudly displayed the enlarged university building and his status (Fig. 1). In 1886, he wrote to Dawson (DP, Jan.1, 1886):

> "Our museum, according to Professor Ward of Rochester, is the largest and best lighted building west of the Hudson, and considering their means the authorities have been very liberal, through the influence of my perpetual "wanting" and the very warm support of Dr. Laws...who is a great admirer of Dr. [Sterry] Hunt and yourself, both from hearing you lecture and from your books. For the last year and a half I have been very highly favoured as shown by the support of my department."

In February, he wrote

> "Today there arrived the skeleton of "Emperor," the largest Indian elephant in this country, and his skin, mounted, will come in May. We are negotiating for some $4000 worth of mammals with Ward to put in our museum." (DP, Feb. 1, 1886)

The elephant that Spencer referred to was originally a circus elephant. It died near Kansas City, and was purchased by Laws, who intended to donate it to the new university Museum. When it came time to pay, however, he was short of cash, and asked the State to pay for it: the legislature refused, but the curators ordered the university treasurer to pay the bill (Stephens, 1962). This was one of the causes of bad relations between the curators and Laws, and by association also between the curators and Spencer.

Though construction had gone well, Spencer found the students and the social aspects of Columbia less to his taste. He was not familiar with the American elective system, and had some trouble adjusting to it. He wrote to Dawson (DP, Sept. 16, 1882):

> "At present there are no honours courses in the College. Each Professor is allowed his own method of teaching, but as the students are not trained to lectures without recitations, I will probably combine the two, and that...will greatly reduce the number of prepared lectures. In Mineralogy, Geology (Physical), Geography (Physical), Historical Geology & Paleontology there will be about 160 lectures and recitations in the year...In general Zoology there will be about 40 lectures, and about 20 more in Economic Geology..."

He complained to Robert Bell (BP, Dec. 17, 1882):

> "...I would not have left King's had it been flourishing financially. [The University of Missouri] is by no means a paradise, it is too hot a country. Then, under the name university, it is really a high school graded down to a common public school. I have students in Zoology from seniors to subfreshmen who take such groups as Arithmetic, Grammar, Geography, Zoology. In Mineralogy I have students who know nothing of Chemistry..."

By 1884, he reported that he liked the university better than he had at first, but "...the town is socially abominable – given to malicious gossiping to a degree I never knew, even in a small place."(BP, Dec.1, 1884). His antipathy only grew more intense, as the legislature refused the funds to furnish or purchase specimens for the new Museum. "There is constant quarrelling going on between the townspeople and the administration, who fortunately does not care much for them...An executive committee [of the governing body]... really governs the institution....Our representative is an old rebel captain [?], by trade a carpenter to the university and a very poor workman. But his principal recreation is drinking and by the liquor elements [in the town] gets in [as State representative]." (DP, May 25, 1887).

In 1886, Spencer managed to arrange a six-month's leave of absence. Since the summer of 1882, Spencer (no doubt influenced by William Dawson) had become increasing sceptical about the supposed role of continental glaciers in eroding the basins now occupied by the Great Lakes: he then regarded these basins as due primarily to fluvial excavation, modified only slightly by glacial erosion and deposition. He explained to Dawson:

> "My primary object is the study of glacier, lacustrine and volcanic phenomena. I will sail from N.Y., direct to Gibraltar and then to Malta, Sicily, Italy, Switzerland, France and probably Norway and afterwards spend a month in Britain." (DP, Jan.16, 1886).
>
> "...the President says stay as long as I like...but there is an Executive Committee here, on which there is a man, or some men, who do not think that a professor needs any more time than a common school teacher (who, by the way, is also a professor in this Country, if he is not a colonel, major, or judge)... (DP, Feb 1, 1886).

The visit proved to be a great success. He wrote to Bell (BP, Sept. 27, 1886):

> "10th of March last I left Columbia, 10th of Sept[ember] I returned ten years younger. I visited Etna, and had a hard

Figure 1 Spencer's letterhead at the University of Missouri, showing the new additions to the main university building.

time in the ascent. Saw Vesuvius in eruption, visited Ischia, etc. In fact, about the Bay of Naples there is more of interest boiled down into one place than anywhere I have ever been....Of all the [other] countries Norway is the most delightful...Ice does not erode, although it may sweep off the country as a broom does the dust off the floor....When I was in Europe before [visiting Göttingen in 1877], I came home without any wish to go back again. I would go back next year if I could."

Some months after his return, he heard that E.J. Chapman, Professor at the University of Toronto, was looking for a "Coadjutor with right to succeed." (BP, May 5, 1887). Andrew Lawson was interested in the same position, and wrote for Spencer's assistance. Spencer explained that he wrote recommending him "in Mineralogy and Lithology" but if the position was really to succeed Chapman he wanted the position for himself, and added: "For God's sake help me out of this place, for...I have said more profane things in three or four months than all my life before ten times over. I like the University very well, and the dep[artment] very much, and would be sorry to leave. But I want to go north into a decent city..."

He also wrote to Dawson, and to George Dickson, his old headmaster at Hamilton Collegiate Institute (and by then Principal of Upper Canada College, therefore on the Board at the University of Toronto). Dickson replied, referring to "your old pupil, Lawson" (SP, May 13, 1887): "...his chances are very good...I have already spoken in favour of Lawson, but this will not prevent me putting in good words [?] for my former colleague and friend." Spencer was not overly enthusiastic about Toronto: he wrote to Dawson (DP, May 25, 1887):

"I would not accept a position as assistant to Dr. Chapman. [Toronto] would be pleasanter, the session shorter, the associations of the faculty superior but less scientific advantages inside, as there has been hostility towards scientific equality with classics, etc. One of the Senate [presumably Dickson] told me that they were not going to grant science degrees and allow the good old classical arts to fall into disfavour. However, Ontario is the most unscientific place in the civilized world, and Toronto University has been responsible in a general measure."

In actuality, E.J. Chapman continued as head of mineralogy and geology until 1895, when A.P. Coleman took over as acting head. Lawson left Canada for California in 1890. A separate professorship of mineralogy and petrography was not established in Toronto until 1902.

By the spring of 1888, Spencer had been dismissed from his position in Missouri, and had a new appointment as Professor at the State University of Georgia in Athens (he had been offered this position some years earlier, but declined it then because it would have included Botany as well as Geology). Laws left Missouri in 1889: he and Spencer remained friends. In 1892, the university museum, on which both of them had expended so much labour, was destroyed in a disastrous fire.

Research and Fieldwork

Spencer's responsibilities at Missouri had left him little time for his own research. He almost certainly had no time for fieldwork in 1883. In 1884, he sent a postcard to Bell, indicating that he would be in Canada for the summer; but if so, we have no record of how he used his time. In December he wrote to Bell that he was in Montreal for the meeting of the British Association for the Advancement of Science (in early August), but could attend for only two or three days. Probably he also visited Ward's in Rochester (the leading U.S. dealer in materials for geology and natural history), in order to investigate the purchase of specimens for the Missouri museum. Later he was too busy to attend the American Association for the Advancement of Science (AAAS) Meeting in Philadelphia. He planned on going to Europe in the summer of 1885, but when that became impossible, planned an excursion by rail to the Canadian Rocky Mountains: that also did not happen. At Christmas, 1885, he went to Washington (where he saw Andrew Lawson), and then to Charleston "and afterwards to one or two other places."

In February, 1886 he sent Dawson a copy of his monograph on Niagara fossils (Spencer 1884: originally published as the first volume of the Museum Bulletin, reprinted in 1886 in the Transactions of the Academy of Science at St. Louis), but remarked: "...for the last eighteen months I have been so crowded with university work that I have not touched a fossil in order to study it..." Indeed, in 1885 he published only a comment on Missouri soils, and two brief notes, one on the occurrence of "boulders of decomposition" near Washington (i.e., residual boulders, produced by deep weathering), and the other on a landslide near Brantford, Ontario. In 1886, there were no publications at all – a rare event for Spencer.

By January, 1886, he had an assistant, Ellsworth Call (see Sources and Notes), and had definite plans for a visit to Europe. The long deferred visit to Europe finally took place in the summer of 1886, and was a great success. The main scientific result was that Spencer's observations in Norway convinced him (erroneously!) that glaciers were incapable of real erosion: "I saw the ice flowing about loose stones held by friction only against the rocks. When barriers were before the glaciers, I saw the upper ice bending and flowing over the lower. When impinging against a moraine in its advance, in place of ploughing, the lateral thrust forced up the ice into anticlinals with fractures and faulting..."(DP, Mar. 1, 1887) These observations were later published in the Transactions of the Royal Society of Canada (Spencer, 1888).

With the termination of his position in Missouri, Spencer was free to spend the summer of 1887 in fieldwork. In August, he wrote Dawson from the AAAS meeting in New York (DP, Aug.13, 1887): "I have again been at work upon the origin of Great Lakes, in Illinois, Michigan, and north of Lake Huron...I have not yet read my paper on glacial erosion. I expect Dr. Newberry will get excited over it....There is here only a small attendance, and very few who are not rabid glacialists...With regard to the

closing of the later basins, I have now abundant evidences of the warping or differential elevation."

By the end of the year he was able to report (DP, Dec. 31, 1887):

> "One paper upon the beach of Ontario I will have ready soon...The lake when this was formed was less than 150 feet above sea and probably at sea level...there is reasonable hope that it can be correlated with [a] marine one in the St. Lawrence valley...Gilbert was generous to give me several of his instrumental measurements...but his glaciers are melting away. I will give you some of my conclusions. 1. The origin of the Ontario basin, of the Niagara escarpment between Ont[ario] and Georgian Bay...is common, Ontario being modified by the Ontario river (along [the] foot of the [the] escarpment) from the Erie basin. 2. The Erie basin drained into Ontario...3. Huron valley drained into Georgian Bay – then much lower (relative to Ontario) than now, [Lake] Michigan into Huron. 4. The absence of beaches in Michigan at the south end is due to the uplift to the N.E. with the consequent submergence of the lower, and the preservation of ... the higher at the south end. 5. After formation of the valleys and subsidence of the region the barrier between the Lakes and James Bay was much lower, and consequently the lake basin was exposed to Arctic currents. 6. The focus or foci of uplift was probably just west of Lake Mistassini...7. The lake barriers are solely the result of warping, some of which was during the contemporary life of the mammoth, beaver and elk, and since the formation of the great beach, which (if Gilbert does not anticipate me) I will call Iroquois, as portions of the beach were used for a trail...by the Indians."

The meaning of parts of this cryptic summary may not be clear to the modern reader: Spencer had earlier proposed that Lake Ontario occupied a pre-glacial river valley, with a submerged escarpment on the southern side (Middleton, 2004). He now began to map a series of beaches, indicating proglacial lakes, the most recent being Lake Iroquois. He recognized that all of the beaches had been tilted by postglacial uplift (now attributed to isostatic rebound). The "glacialists" had already attributed the existence of such lakes to damming by large ice sheets, a theory which Spencer (and Dawson) strongly opposed. Spencer's earliest paper on "Terraces and beaches about Lake Ontario" was read to the Montreal meeting of the AAAS, and published in 1883: it contains two maps, neither of which shows the Iroquois beach, though the text discusses beaches above the level of Lake Ontario and shows that Spencer was familiar with the earlier work of Thomas Roy (described by Legget, 1976). It also shows that Spencer confused glacial moraines (e.g., the Oak Ridges moraine) with gravel beaches, a confusion which persisted into his later papers. His first paper on "warping of the earth's crust" appeared in 1887, and his major paper on the Iroquois beach was read in 1888 to the Philosophical Society of Washington, and published in 1890 in the Transactions of the Royal Society of Canada. Before he could publish his broader theories, however, he needed to undertake more fieldwork.

PROFESSOR OF GEOLOGY, STATE UNIVERSITY IN ATHENS, GEORGIA

In July 1888, Spencer was appointed Professor at the State University. He wrote to Dawson (DP, Oct. 25, 1888): "Last summer Biology and Geology were separated, and I was called to the Chair of Geology and accepted. I remained at field work [see below] until the end of September. I like my change...with Athens and with the people I am very much pleased. I somewhat dread the long summer although the heat is not excessive as we are high. I expect also to be appointed State Geologist, but I don't want it just yet as I want to put in another summer in working out the beaches of the Lake region with the marine deposits of L[ake] Champlain and some other questions."

At the end of 1889, he was appointed State Geologist, and remarked in a letter to Dawson (DP, Dec. 21, 1889) that since the law did not allow holding a double office, he would have to give up his position in Athens. He moved to Atlanta in July, 1890 (DP, June 16, [1890]).

His correspondence in 1888-1889 shows that Spencer was still trying to obtain the Chair of Geology at Toronto: but he seemed unlikely to get it, even if Chapman retired (which he did not). Bell had told Spencer (DP, Dec. 3, 1889) that he would support Lawson. In the same letter to Dawson he remarked: "The Geological and Natural History Departments [at Athens] are unequipped and there is no money...If I get the chance of course I would return to Canada...but my knowledge of southern drift has been worth my residence...[and] I really quite love Georgia."

STATE GEOLOGIST OF GEORGIA

The first Geological Survey of Georgia was a reconnaissance carried out by John R. Cotting from 1836 to 1840. The second Geological Survey was authorized in 1874, and George Little appointed State Geologist. As funds were provided only for five years, the Survey was discontinued in 1879. The Survey was revived by a bill passed in 1889, and Spencer was appointed as of July 1, 1890, with two assistants: C.C. Anderson, a civil engineer in charge of hydrographic work, and E.T. Whatley, as assistant geologist (Cave, 1922; Furcron, 1965). Furcron remarks:

> "Although at this time the mining of gold was exceedingly prominent in Georgia, Spencer spent most of his time upon limestones, shales, and sandstones of Northwest Georgia, for which at that particular period, there was not much commercial use. [He] prepared the first geological map of the northwest section of the state. His map, accompanied by an extensive text upon Paleozoic rocks represents, in fact, the first important publication upon geology by the State of Georgia...[Spencer] was not capable of converting his knowledge of science and research into service. [Probably] there were not 10 men in the entire state...who could have read his book with understanding."

A somewhat different perspective was presented by an anonymous review of his report, published in the American Geologist: "...the chief has been handicapped by the appointment and bare-faced maintenance on the survey of *political* assistants, whose work he would not accept, among which was the farcical discovery of worthless diamond

mines. Furthermore, the survey has been attacked by interested but unscrupulous gold miners, who, without his indorsement, could not put their lands upon the market." (Anonymous, 1893; the tone suggests that these words were written by Spencer himself!). Evidently the next appointee, William Smith Yeates, was able to overcome these obstacles, and he remained as a successful State Geologist until 1908 (Furcron, 1965). In any event Spencer yielded to pressure and resigned in 1893. Following this, Spencer never held any other permanent appointments. Instead he set up as an independent geologist, based in Washington DC (from 1894 to1919), and began studies of the Miocene to Recent geology (and marine topography) of the Gulf of Mexico, and later the Caribbean, Mexico and Central America.

RESEARCH ON THE GREAT LAKES, 1888–1893

Fieldwork

Spencer devoted the whole of the summer of 1888 to fieldwork on the Great Lakes. In May he wrote to Dawson from Ann Arbor, Michigan (DP, May 12, 1888): "I had just returned here, preparatory to going to Canada, to commence upon beaches about Huron and Erie. I had been following up Gilbert's Ohio beaches, in order that I might make a correlation on the Canadian side of the Lakes. When they disappear by interruption then Gilbert & Chamberlin thrust in a glacial dam. They regard all the stratified Pleistocene of the St. Lawrence as newer than even the terraces & lake ridges."

Two weeks later he elaborated further (DP, May 21, 1888):

> "I went to Michigan to bind together facts collected last year, which were not clear – nor could they be clearly understood at that time. However, I am now able to dissipate more of Gilbert's ice dams. His four beaches in Ohio I have carried up to Lake Huron. ...I have not followed them westward yet.
>
> "In a conversation with Prof. Chamberlin in Ann Arbor (he chanced to be there), he insisted upon ice dams (that is before I had finally settled the question in Mich[igan].) I asked him how his dam could be across the upper parts of Huron (closing the Mackinaw outlet, and I had not then discovered the positive proof of the upper channel at Lapeer – connecting with L[ake] Michigan) with many beaches 400 feet higher. His reply was he doubted the beaches. It piqued me for I know a fossil beach better than nine-tenths of geologists, for they are not always easily learned, & before I had learned to know them I made many mistakes. But this outlet by Lapeer overthrows the validity of his dam at Mackinaw St[rait] and more. On the southeastern side of Lake Huron I have got the exact series that occur on the western side, and so I doubt not I will be able to connect these high level beaches. The result will be positive proof of open water in from seven to ten places between Gilbert's Glacial Lake Erie and the low country of the Mississippi and Ohio valleys, and the sea."

He asked Dawson to loan him a level for the rest of the summer (later he told Dawson he had used it to run nearly 100 miles of levels that summer): it had arrived by July, when he wrote again, this time from Lucan, Ontario (DP, July 11, 1888):

> "I have just circled around here from a journey of over 400 miles in two weeks and a half, of which over 150 were accomplished on foot. Tomorrow two of my old graduates join me in the work [W.W. Clendenin, from Missouri, and W.J. Spillman: see Sources and Notes], and taking a carriage, we are going to camp out.
>
> "Exclusive of outliers there are four beaches between Lake Erie and an altitude of 900' above the sea. But north of Lake Erie they were hard to follow as there were so many peninsulas and bays...
>
> "I had decided at first to follow out the Iroquois Beach & get its connections with Lake Champlain clays before doing my work in Ontario, but I changed my plan and will not do that now, as I want to get the northern equivalent of the rise on the beaches as soon as possible & find they are continuous to the north (thus melting the ice dams) and to finish getting the evidence of connection of Georgian Bay to Lake Ont[ario]."

In August he attended the AAAS meeting in Cleveland, Ohio and delivered papers on the inadequacy of glacial erosion, which were disputed by N.H. Winchell and J.S. Newberry (DP Sept. [1888]). Afterwards he continued the fieldwork and returned Dawson's level in September. In October, Dawson replied to his letters, with some advice (DP, Oct. 29, 1888): "I think hitherto your results have not received all the acceptance they might have had, on account of imperfect statement, more or less difficult to comprehend and realise. Such researches demand full and clear statement and fine illustration by maps, etc."

Though Spencer had told Dawson that he wanted to devote the summer of 1889 to further fieldwork on the lake beaches, he did not do so. As he explained to Dawson (DP, Aug. 30, 1889):

> "...I was needed here [in Georgia and Alabama] to make a geological survey for a new railway – through a mineral[?] country – I gave up that which was dearer to me – not so much for the $1000 fees for the summer (my report will be written later) as to become acquainted with southern geology – as the line is over 200 miles reaching[?] from drift and Cretaceous on one side across Archean of various groups – over formations in Alabama reaching from Cambrian to Carboniferous. Off my R[ailwa]y. line I have made some study of the southern drift. Economically, my results are to me very satisfactory. Upon my recommendation the right of one town has been secured, and there will be several more, with location of furnaces[?] etc and the general development of an excellent country."

The results of his survey were published (Spencer, 1889). Possibly this is the type of consulting that supported Spencer later, after he lost his position with the Georgia Survey. He was always very discreet about his business activities (and there were no further publications of the results), so we have no way of knowing for sure what they were. Nevertheless, Spencer regretted the loss of his summer (DP, Aug.30, 1889): "This, apart from the money, the experience in Southern Geology and the advantage in teaching is all that I have accomplished – small results to those that I had promised myself in working

on the beaches & their relation to marine deposits. I am sorely disappointed at not getting to AAAS."

The following two summers (1891, 1892) were presumably spent in work for the Georgia Survey: there is little archival information about his travels. In 1892 Dawson suffered a severe attack of pneumonia and was ordered by his doctors to rest in a warm climate. His biographers (Eakins and Eakins, 1990) state that he spent the winter in Florida, but there are letters to Spencer from Savannah, Georgia (DP, Jan. 7, 1892 [but more probably 1893]) and North Carolina (DP, Mar. 29, 1893). He declined Spencer's invitation to visit him in Atlanta. In December 1893 there are two letters from Spencer to Dawson (then back in Montreal). By then Spencer's main interest had shifted to Niagara Falls. He was also planning an expedition to the Arctic (which never took place) and still considering various university positions. In 1894, however, he left on an expedition to Cuba, and when he returned, established himself as a consultant, based in Washington, DC.

Previously known portraits of Spencer come from a much later period, but a photo recently discovered in the Smithsonian archives, though undated, must be from about the time when Spencer settled in Washington (at the age of 43: Fig. 2).

A letter to Dawson (DP, Nov 17, [1894]) remarks that when his paper on Niagara Falls was written he "wished to avoid the controversial question of Glacial dams. On that point [he has] now fully made up [his] mind that they did not exist for the facts in the Adirondacks and lately discovered data in the New England mountains disprove the possibility of such." Unfortunately for Spencer, this was about the time that Chamberlin, Leverett and Taylor were finally uncovering the evidence that incontrovertibly proved their existence (see discussion below).

Spencer's Views on the Evolution of the Great Lakes

Spencer's investigations of early Great Lakes beaches, and the warping of beach elevations by subsequent Earth movements, were a major contribution, carried out at a time when accurate maps did not exist, and travel was still difficult in rural Ontario. Spencer himself recognized and named four major lakes: Algonquin, Warren, Lundy, and Iroquois (Spencer, 1890a; 1891a,b; Fig. 3). He mapped the Ontario part of the Lake Iroquois shoreline in detail, using levelled elevations (an improvement over the barometric measurements used by many other investigators), and extended Gilbert's mapping of the New York portion. A.P. Coleman's later work refined Spencer's mapping, and so it is generally cited rather than Spencer's. Detailed knowledge of the other lakes, however, came later after more precise mapping and levelling, combined with study of the moraines and stratigraphic studies, and was the work of many investigators, mostly supported by state surveys (e.g., Gilbert in Ohio; Leverett in Indiana and Michigan; Taylor in Ontario).

Spencer's view that proglacial lakes were formed at sea level was shared by some other workers both before (Lyell, Hall) and after his own studies. For example, Taylor (1895) believed at first that the Lake Iroquois beach was marine, a view he later abandoned. The absence of marine fossils was not thought to be definitive evidence to the contrary. In Scotland, Darwin (influenced by Lyell) published a marine interpretation of the Parallel Roads (beaches) of Glen Roy, and only reluctantly admitted his error in the 1860s (Rudwick, 1974). The glacial dams at Glen Roy were, of course, very small compared with those required in the Great Lakes.

Figure 2 Photograph of Spencer, aged about 40. Smithsonian Institution Archives, Record Unit 7177, George P. Merrill Collection, Negative #2004-18868, reproduced by permission of the Smithsonian.

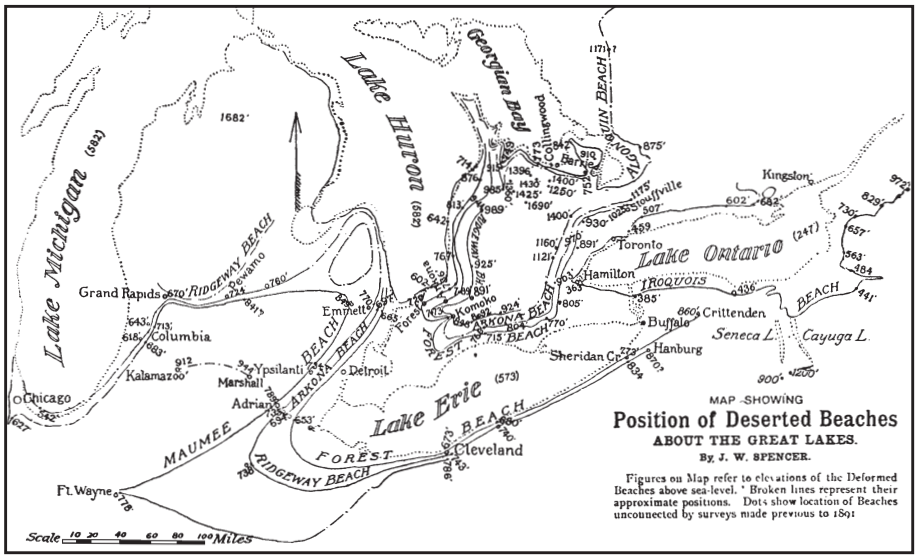

Figure 3 Preglacial lake beaches in the Great Lakes region, as interpreted by Spencer, based mainly on his mapping in 1887 and 1888 (from Spencer, 1891a).

The increasing evidence for outflow channels and large glacial dams (see below) made the marine interpretation an eccentric view after the beginning of the twentieth century (see Leverett and Taylor, 1915; Tinkler, 1994).

Spencer's narrow focus on beaches and river valleys led to his misinterpretation of some moraines as beaches (e.g., Leverett, 1892), and his neglect of other phenomena that could be used to unravel relevant glacial history, such as moraines and drift stratigraphy. Their study by others led to the discovery of multiple glaciations, separated by interglacial periods. As early as 1881, Spencer discussed the excellent work by Hinde (1877) on the section at Scarboro' Heights (Toronto), which not only established the existence of an interglacial, freshwater lake, but also gave a cogent criticism of Dawson's ideas about deposition of till from icebergs: Hinde, however, misinterpreted the Dundas valley as excavated by glaciers, and Spencer reacted by claiming that the only evidence for glacial action was "scratches at the northwest end of Lake Ontario...", ignoring Hinde's interpretation of the well-exposed tills. Spencer's neglect of till and moraines was particularly surprising, because Robert Bell, who in the 1870s became Spencer's closest professional friend, was a glacialist and had been one of the first geologists to map moraines (near Ottawa, published 1863 in the *Geology of Canada*). Moraine ridges are prominent in the areas with which Spencer was most familiar, at the west ends of both Lake Ontario and Lake Erie, but Spencer never mapped them.

There is evidence in letters sent to Taylor and to Fairchild between 1908 and 1910 that by that time Spencer did accept glacial dams, particularly for Lake Iroquois. He wrote that he intended to declare this view in a new publication, but the closest he came was in Spencer (1913, p. 218). It is also clear from Spencer (1910) that he also belatedly recognized that till ridges should be interpreted as glacial moraines, and that there was more than one period of glaciation.

Progress in glacial geology has been well reviewed by Flint (1965; see also Fairchild, 1898; Merrill, 1924; Rieck and Winters, 1981). Flint noted Gilbert's pioneer work in mapping end moraines, followed in 1877 by the work of Chamberlin (for references and discussion see Alden, 1929). Ice contact features known to early geologists included kettles (correctly interpreted by Whittlesey in 1859) and kames (by Winchell in 1873). Though Spencer measured a few striae he did not map them systematically, as Chamberlin and his associates did (particularly Leverett), nor did he pay any attention to the evidence of erratic boulder trains. The moraines in Ontario remained incompletely known until Taylor was hired by the GSC to map them (e.g., Taylor, 1909, 1913).

It was Spencer's misfortune that in his Canadian studies, he was working in the same field as such great geologists as J.S. Newberry, G.K. Gilbert, and T.C. Chamberlin, who also directed the early work of Leverett and Taylor. Though Gilbert never achieved his ambition to write a comprehensive work on the evolution of the Great Lakes, a definitive synthesis was carried through by the combined labour of many American geologists, working collaboratively; and first published by Leverett and Taylor (1915). Spencer's personality prevented him from participating fully in any such collaboration, and his earlier synthesis was largely ignored after 1915.

The key to understanding the proglacial lakes was the theory of ice dams: according to Taylor (1899) this was first proposed by J.S. Newberry in 1874, based on Gilbert's mapping at the west end of Lake Erie (for discussion of Gilbert's early work see White, 1980). The idea is simple, but demanded mapping of moraines as well as beaches, and identification of the outflow channel that drained each lake. Basically the position of the ice dam is recognized from two observations: the presence of one or more major terminal moraines deposited when there was a hiatus during the period of ice recession, and the disappearance (or weakening) of beaches as the ice barrier is approached (so that beaches are found only on the sides of the basin where the ice barrier was absent). Thus beaches are correlated with recessional moraines, and the beach elevation remains the same until the ice barrier retreats to a position where a new lake outlet is exposed. Since many of the proglacial lakes were deep, it must be inferred that the ice barrier was thick, of the order of several hundreds of feet – so the theory requires major continental ice sheets of a type that was very incompletely known in the nineteenth century. Even the Greenland ice sheet (investigated by several pioneer explorers, and by Chamberlin in 1894 for comparison with Pleistocene ice sheets) proved to be a poor analogue, because it is confined by mountain ranges.

As late as 1890, Chamberlin expressed reservations about the effectiveness of ice dams (see Alden, 1929). Spencer (1891c) summarized the evidence for his theories and against glacial dams. The main evidence in favour of his theories was the abundant evidence from raised beaches of very large changes in elevation: most of these we now accept to be the result of isostatic rebound following the removal of immensely thick ice sheets (a theory that was not fully developed for another 30 years). Indeed Spencer used the evidence to cast *doubt* on "the idea of hydrostatic stability of the continent," and thought that ice sheets a mile thick were simply preposterous. His argument against ice dams was basically a uniformitarian one – there are no large modern lakes dammed by glaciers.

As Fairchild (1898) pointed out, the final proof of ice dams for the main proglacial lakes depended on the correlation between beaches and moraines in the same basin, and this was accomplished for Erie by Leverett (1892, 1895) and for Huron by Taylor (1896). In 1899, Taylor clearly laid out the evidence for "great ice-dams" to explain the proglacial ancestors of the Great Lakes, and inferred that the ice lobes occupying the lake basins "were broad lobate masses [that] moved forward with extreme slowness...No doubt their fronts were undercut to some extent by the waves and pieces were sometimes broken off [but] in no case...was it effective enough [during

the advance] to make the lobe front concave...it must have been hundreds of feet thick near the edge..." (Taylor, 1899, p. 22).

Based on the evidence available in 1899, Taylor concluded, in rejecting Spencer's views (p. 32) "It is hard to see how marine submergence can have any definable relation to features which have a demonstrable dependence upon a receding dam or barrier." Not surprisingly, Spencer did not even attempt to refute Taylor's arguments.

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SOURCES AND NOTES

Much of this article is based on archival (unpublished) sources. These include letters to John William Dawson in the McGill archives (cited as DP, followed by the date of the letter); a file of Spencer's testimonials in the McGill archives; the Spencer fonds (SP) and his letters to Robert Bell (BP) in the National Archives; and his letters to J.P. Lesley in the American Philosophical Library in Philadelphia (LP). In quoting from the letters, I have standardized the spelling, capitalization, and punctuation: [?] indicates doubt about my transcription of Spencer's handwriting. A good bibliography of Spencer's publications is given by Shaw (1924), and the Bibliography of Geological Literature on North American, 1785-1918, gives an even more complete list.

Richard Ellsworth Call later became an authority on molluscs, and coauthored a book on Mammoth Cave, Kentucky (Keyes, 1922).

William Wallace Clendenin (b. 1862) later became State Geologist of Louisiana.

William James Spillman (1863-1931) became a well-known agricultural economist and pioneer in farm management research, perhaps now best remembered for having discovered the mathematical form of the law of diminishing returns. Following an appointment at Washington State College, he served for 16 years with the US Department of Agriculture, and was appointed to the National Academy of Sciences (E.E.E., 1935).

It seems that when the choice of field assistants was left to Spencer, he could spot talent.

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