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Résumé de l'article

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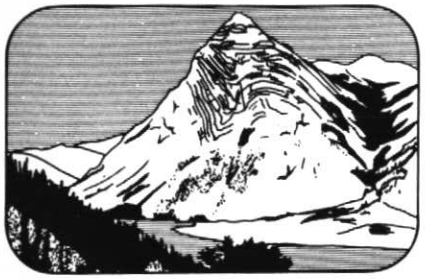

History of Canadian Geology

The Contributions of J.W. Dawson (father) and G.M. Dawson (son) to the Theory of Glaciation

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Summary
Both J. W. Dawson and G. M. Dawson, father and son, wrote about glaciation in Canada in the late nineteenth century, but their philosophies and contributions often are misidentified. J. W. Dawson was a proponent of the deposition of glacial drift from floating ice, but believed that ice caps covered some highland areas. His son, G. M. Dawson, was indoctrinated with the floating ice theory, but his field studies in western Canada convinced him that glaciers deposited most of the drift there. Both the Cordilleran and Laurentide Ice Sheets were named by him. He reserved final judgement concerning the origin of the drift on the prairies because it contained foraminifera that he correctly identified as Cretaceous, but which an English micropaleontologist, considered to be an expert on Cretaceous forms, misjudged to be recent forms.

Introduction
Recently my colleague R. P. Goldthwait made the following statement in a short historical paper on Quaternary geology in North America: "The last major opposition to such widespread glaciation was J. W. Dawson of Canada, but he had produced good studies from Manitoba west before he died in 1899." (Goldthwait, 1982). This statement confuses and combines the works of John William Dawson, former principal of McGill University, the father, with that of George Mercer Dawson, former director of the Geological Survey of Canada, the son. The error is understandable, as probably few people are informed on the specific contributions to glacial geology of these two late-nineteenth century geologists.

J. W. Dawson (Fig. 1) was indeed the last important proponent of the floating-ice theory of drift deposition. He considered both icebergs and drift ice (floating sea ice) to be the agents of drift transport. He recognized that glaciers existed in highland areas and did visit at least one glacier in the Alps (J. W. Dawson, 1866). He is better known as a paleontologist than for his glacial geology (Clark, 1972), but he wrote extensively on the latter subject in "The Canadian Ice Age" (J. W. Dawson, 1894). He was a prolific writer, and although paleontology certainly dominates the 288 titles in his geological bibliography (Nickles, 1923) there are at least 33 titles that are related to the Pleistocene, most with a paleontological emphasis. He made field observations on Pleistocene geology in the Maritime Provinces (J. W. Dawson, 1848), where he spent his formative years. Several papers on the St. Lawrence Lowlands near Montreal, where he lived most of his life, were incorporated into "The Canadian Ice Age". He had a summer home near Metis, on the lower St. Lawrence River [estuary] and reported on the Pleistocene geology there (J. W. Dawson, 1866). He made one trip into western Canada, primarily to look at paleontological sites, but did not work "from Manitoba west" as Goldthwait stated.

G. M. Dawson (Fig. 2), the son, received some geological training from his father at McGill University, then further education at the Royal School of Mines in London (Adams, 1901). He worked on geological surveys in western Canada from 1873 onward, and was director of the Geological Survey of Canada from 1895 until he died in 1901. A measure of the respect many Canadians had for G. M. Dawson and his work was demonstrated by the surveyor and later Commissioner of the Yukon Territory, William Ogilvie, who named the city of Dawson in his honour. It is hardly surprising that the young G. M. Dawson started his geological career with the same views on drift deposition as his father. However, his conceptions of glacial geology underwent a metamorphosis as his field experience accumulated. Although he did not contest his father's theories in public forums, he certainly became an advocate of the glacial theory.

The purpose of the present article is to eliminate some of the confusion concerning the contributions to the theory of glaciation of these two men, both of whom were highly respected scientists in Canada. Both seem to be viewed by present-day Quaternary scientists under the stigma of having chauvinistically defended an untenable hypothesis long after it had been abandoned for a better one by the majority of their colleagues. This may be true of J. W. Dawson, but it is not true of his son, who should be admired for his gradual transition from the floating ice dogma to the glacial theory by sound reasoning based on careful field observations, as well as by constant testing of hypotheses as new data accumulated. His conversion provides an excellent example of the application of the method of multiple working hypotheses. His continued doubt about the glacial origin of drift in the Prairies of Canada shows a healthy skepticism in the face of some inconclusive evidence.

George Mercer Dawson (1849-1901)
G. M. Dawson, the modern scientist, (Eak-

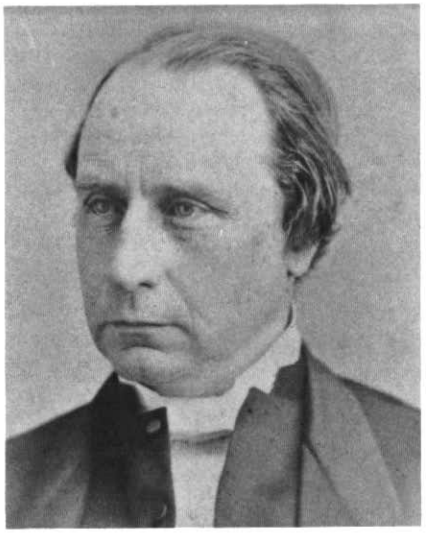

Figure 1 *John William Dawson, about 1865.*

Figure 2 *George Mercer Dawson, in the early 1890s.*

ins, 1972) is discussed first. His bibliography (Ami, 1901) contains 22 titles on Pleistocene geology and geomorphology and this comprises about a fifth of his publications. It is obvious that, when he started his work in 1873 along the International Boundary from Manitoba westward, he believed in marine submergence of the region and the deposition of the drift from floating ice. As his field observations expanded, and as he began mapping in the Cordillera, he failed to find convincing evidence for Pleistocene marine submergence, and by 1890 he had accepted the glacial theory mainly on the basis of his own field observations (G. M. Dawson, 1890; Eagan, 1972). He subsequently named both the Cordilleran and Laurentide Ice Sheets, terms which have been accepted by glacial geologists for the past nine decades. He continued to seek evidence to settle the remaining question of the possible marine origin of the drift on the Prairies (G. M. Dawson, 1897b), although by the mid-1890s his main geological interests lay elsewhere.

In an editorial comment on a paper by J. B. Tyrrell, his former pupil and field assistant, G. M. Dawson (1897a) emphasized that the Laurentide glacier as he conceived it was a horseshoe shaped *mer de glace* on the Laurentian Plateau around Hudson Bay. He believed that it flowed down in all directions from higher to lower ground in conformity with the slope. Clearly, he conceived it to be less extensive than present use of the term implies. He pointed out that there was no evidence that erratics from Hudson Bay had crossed the watershed to the south or southwest. He doubted such a great ("long") extent of Labradorean ice and pointed to Chalmers' conclusion that no glacier ice had crossed the St. Lawrence valley below Quebec. The existence of independent centres of ice dispersion on the highlands of southern Quebec, New Brunswick and Maine, for which Chalmers had suggested the name "Appalachian Glacier", opposed the concept of a more extensive Laurentide ice sheet radiating from a centre in Labrador. These views seem to show some influence of the theory that glaciations originated in highlands, which was then preferred by several students of the problem, for example, J. D. Dana (1895).

John William Dawson (1820-1899)

Sir J. W. Dawson, the father, was born in Pictou, Nova Scotia in 1820 and studied in Edinburgh, He became acquainted with Charles Lyell when the latter visited North America in 1841 (Clark, 1972). He became a protegé of Lyell and kept up a steady correspondence with him as long as Lyell was active. Lyell has been described as the "high priest" of the doctrine or uniformitarianism, to which a prominent place was given in the first edition of his *Textbook of Geology,* published in 1830 (Shea, 1982). For the young J. W. Dawson the epitome of uniformitarianism was visible in the transport of debris by floating sea ice in nearby Northumberland Strait (oral communication, P. R. Eakins). Certainly in later life he frequently saw floating ice in action in the St. Lawrence River and Estuary (Fig. 3) and even in the low-lying part of the city of Montreal. It is doubtful that anyone who has not lived where floating ice is an annual coastal hazard can appreciate the impact that this must have had on J. W. Dawson's views of the transport of drift.

Charles Lyell immediately accepted the theory of continental glaciation when Louis Agassiz visited Scotland in 1840 and showed him and others field evidence. However, he still thought that drift in lowland areas was the result of marine submergence and the transport and deposition of debris by floating ice. This hypothesis, and not the earlier one of ubiquitous sumbergence and transport by floating sea ice, is the hypothesis that J. W. Dawson found support for in southern Quebec along the St. Lawrence River. Here, fossil-bearing marine sediments are common at altitudes as high as 500 feet (170 m) above sea level. Boulders and sand are still being transported by floating sea ice every winter (Fig. 3).

J. W. Dawson thought of a Pleistocene submergence similar to the Cretaceous submergence (Fig. 4), but with ice sheets covering highland areas such as the Appalachians. For Quebec and the Maritime Provinces his "Glacial Map of [Eastern] Canada" (Fig. 5; J. W. Dawson, 1893) in part resembles recent maps that represent glacial events of about 12,000 years ago. For the country to the west, the literature available then had abundant references to extensive aqueous sediments at the surface. The geologists who studied these thought that they were deposited in glacial lakes rather than in the sea. However, J. W. Dawson turned a blind eye to the lack of marine fossils and preferred to believe that the sediments were marine. He cited the finding of marine fossils in the drift 200 miles north of Lake Superior by Robert Bell as evidence for a marine origin (J. W. Dawson, 1894, p. 209). Paradoxically, Robert Bell was a vehement glacialist, maintaining that the erosion forms on the bedrock surface could not possibly have been produced by floating ice. J. W. Dawson seems to have accepted Bell's interpretation to the extent that, on his map showing the Pleistocene marine submergence of North America (Fig. 4), he shows a U-shaped ice sheet extending southwest from central Quebec, west across Northern Ontario, and northwest into the Northwest Territories. This was considered to be a highland glacier (ice cap), and it covered the area where Bell described the glacial erosion forms. The pattern undoubtedly was influenced by his son's field work, and implies some compromising of the vehement anti-glaciation opinion expressed in 1893 (below).

A good statement of the concept of glaciation as espoused by J. W. Dawson is in a newspaper clipping found among Dawson's papers by P. R. Eakins (personal communication; McGill University Archives). It is from an unidentified English newspaper published in September 1871, and is a report of a lecture by a Mr. Mackintosh "..on boulder-clay & gravel, and the antiquity of man." These are excerpts:

> "He [Mackintosh] believed that the Lake District and Wales may at first have been covered with a valley-ignoring ice sheet, which, as the surrounding sea encroached, may have sent off ice-bergs [sic].... But as a great part of the northern drift...must have been dropped into a sea not sufficiently deep to float icebergs, and as it must have radiated irrespectively of the direction of the valleys...he was convinced that belts of coast-ice, first freezing around beach-shingle and boulders, then receiving debris from superjacent cliffs, and finally, marching off with cargoes of drift, and dropping it as the ice grounded or melted...was the main cause of the transportation of boulders."

Conclusion

Although J. W. Dawson acknowledged the existence 2of ice sheets in highland areas he never wavered from the view that the predominant process in the transport of drift

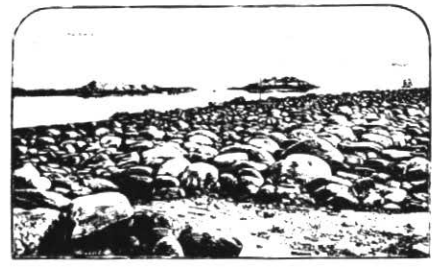

Figure 3 *Reproduction of the frontispiece in J. W. Dawson (1894), bearing the caption "Modern Boulder-formation or 'Moraine' produced by sea-born ice, Little Metis, Lower St. Lawrence [from a photograph by Henderson]." It also appears in Dawson (1893) facing page 345, with the caption "MODERN BOULDER BEACH.— Little Metis, St. Lawrence Estuary (from a Photograph). Showing the manner in which travelled boulders are piled up against the beach by the floating ice of modern time (p. 346)". Recent work has shown that these boulders rest on marine sediments.*

was by floating ice. His essay entitled "The Great Ice Age" (J. W. Dawson, 1893) is dedicated to David Milne Home, "An eminent and judicious advocate of sound and moderate views respecting the Glacial Age" and opens with the following statement (page 345):

> "Scientific superstitions, understanding by this name the 1reception of hypotheses of prominent men, and using these as fetishes to be worshipped and to be employed in miraculous works, are scarcely less common in our time than superstitions of another kind were in darker ages. One of these which has been dominant for a long time in geology, and has scarcely yet run its course, is that of the Great Ice Age, with its accompaniements [sic] of Continental Glaciers and Polar Ice Cap. ....."

In fairness, it should be pointed out that the elder Dawson's 2concept of ice caps on highlands with extensive marine submergence in lowland areas, was only an extreme variation of the glacial theory expounded by J. D. Dana in his textbook (Dana, 1895). Dawson's North American contemporaries who supported the theory of glaciation in lowlands as well as highlands, and thus essentially in its modern form, were less numerous than is often presumed. They included mainly Charles Hitchcock and his protegés, such as Warren Upham. Louis Agassiz had oversold his glacial theory and, for a variety of reasons beyond the scope of the present article, several prominent geologists of the late nineteenth century did not find it to be entirely plausible. They, like Dana (1895), modified the Agassiz theory in varying degrees to retain the concept of the origin of glaciation in highlands and the marine submergence of lowlands.

Both Charles Lyell and J. W. Dawson recognized the importance of sea ice (drift ice) acting on shorelines, and no doubt both would have been gratified with the recognition accorded this phenomenon (*glaciel*, Dionne, 1974) by the "Symposium on the Geologicl action of drift ice" which was held at Quebec, April 20 to 24, 1974.

In contrast to his father, G. M. Dawson fully accepted the theory of widespread continental ice sheets covering most of Canada. However, in his last paper on glaciation (G. M. Dawson (1897b) he still expressed some uncertainty about the origin of the tills ("bowlder clays") of the Great Plains that lay well beyond the limits of the Laurentide Ice Sheet that he defined. Earlier, he had found Cretaceous foraminifera in them and had concluded that these boulder clays were not deposited in an ice-age sea. Because he was not an expert in foraminifera, he sought further advice. T. C. Chamberlin had found similar occurrences at South Chicago. G. M. Dawson sent specimens from the Canadian plains to Joseph Wright in England, a British micropaleontologist. Wright reported that all identified species were referable to recent species and that the state of preservation, compared with foraminifera in the Cretaceous chalk of England, suggested a recent origin; but he admitted that he was not familiar with Cretaceous forms in Canada. From this exchange G. M. Dawson concluded that Cretaceous foraminifera occur together with recent forms in the drift, representing an ice-age sea. Although he wrote nothing further about this matter, he does not seem to have been wholly satisfied with this conclusion.

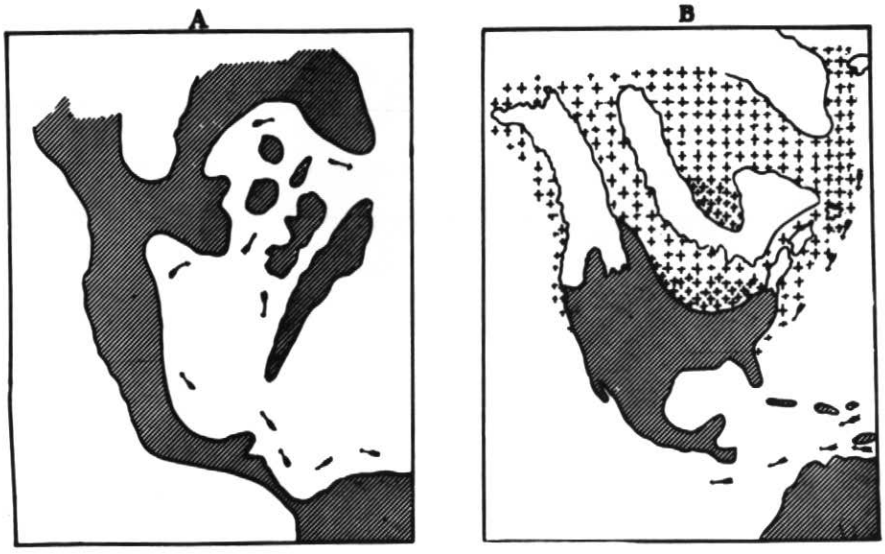

Figure 4 *Reproduced from J. W. Dawson (1894), p. 77, Fig. 6, where the caption reads: "America in the Cretaceous (A) and Pleistocene (B). Shaded portions, land; crosses, ice-laden sea; unshaded bands, glaciated mountains." The same figure appeared in J. W. Dawson (1893) facing page 385, where it has the caption "North America in Periods of Warm and Cold Surmergence [sic]. (A) Early Cretaceous (B) Glacial or Pleistocene. Unshaded portion.—Snow-clad Mountains.—Crosses. -Ice-laden sea. These maps illustrate the probable geographic conditions of warm and cold periods. (p. 388.)"*

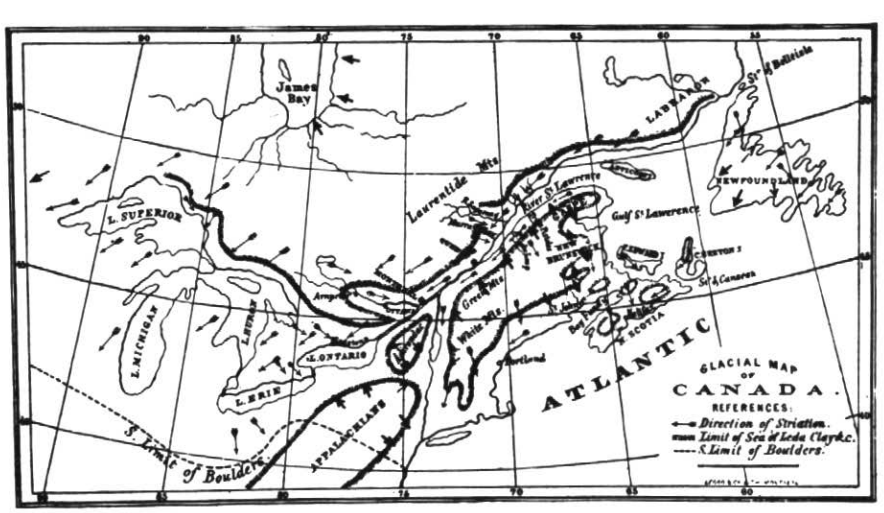

Figure 5 *Reproduction of a map from J. W. Dawson (1893, p. 150) with this caption augmenting the title lettered on the map: "NOTE.- This map should have been entitled Glacial Map of Eastern Canada."*

Acknowledgments

I am grateful to Dick Goldthwait for inadvertently creating an opportunity to explore and, it is hoped, shed some light on an item of historical confusion. Discussions with Peter Eakins, who is working on the geological papers of J. W. Dawson, have been invaluable; he also provided the portraits and a copy of clippings from the McGill University Archives. The manuscript

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