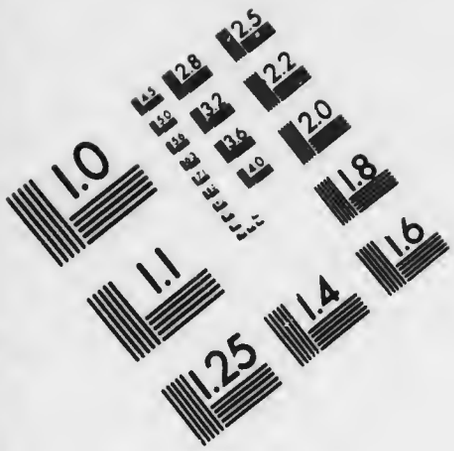

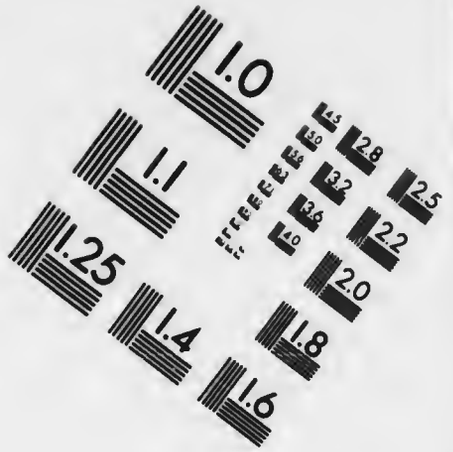

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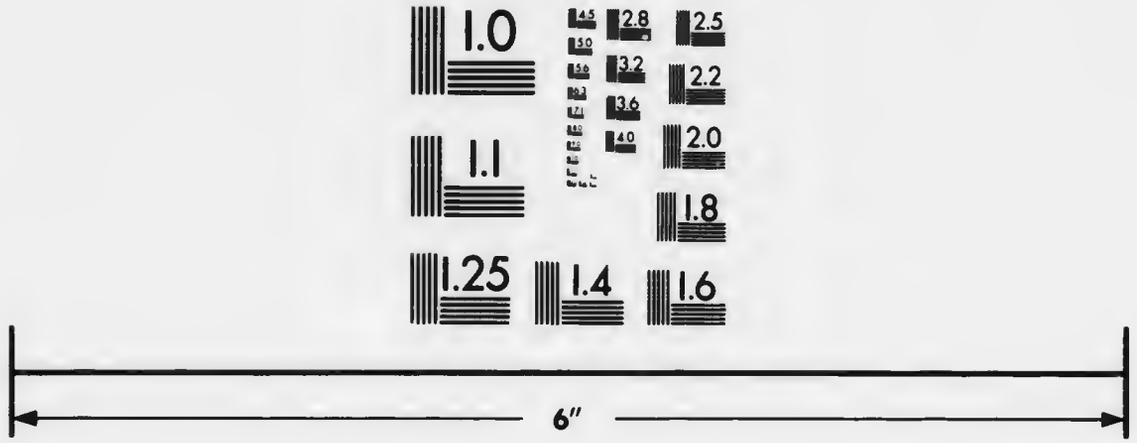

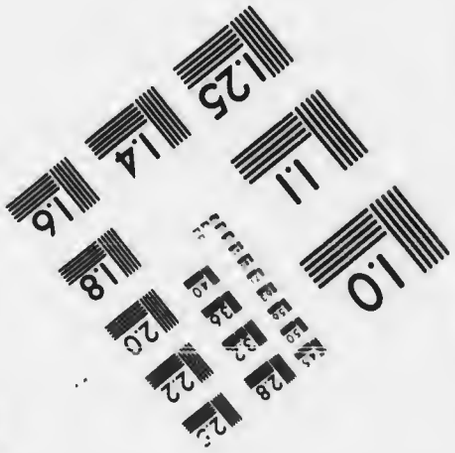

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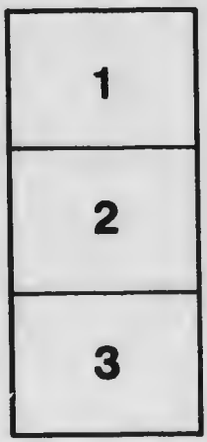

PROVINCE HOUSE

CANADIAN PLEISTOCENE.

[*Extracted from the* GEOLOGICAL MAGAZINE, March, 1883.]

TRÜBNER & Co., 57 and 59, Ludgate Hill, London.

[*Extracted from the* GEOLOGICAL MAGAZINE, Decade II. Vol. X. No. 3, p. 111, March, 1883.]

CANADIAN PLEISTOCENE.

By J. W. DAWSON, LL.D., F.R.S., etc., etc.

REFERENCE is sometimes made, in the course of the active discussion of the Glacial age in the GEOLOGICAL MAGAZINE, to the Pleistocene of Canada, a country which, perhaps, as much as any other, in its great extent from the Atlantic to the Pacific, and from latitude 45° to the Arctic Sea, affords opportunities for the study of the deposits of this period. It has occurred to me, in connexion with this, that it might be useful to your readers to present to them a short summary of Canadian facts, as I think I have established them in publications on this subject, which are, perhaps, better known in this country than in England.

In the St. Lawrence Valley, which may be regarded as a typical region, these deposits may be tabulated as follows, in ascending order :[1]—

(*a*) Peaty beds under Boulder-clay. (*b*) Lower stratified sands and gravels (Syrtensian deposits of Matthew).	These represent land surfaces and sea and coast areas immediately anterior to the Boulder-clay.
(*c*) Boulder-clay or Till; hard clay, or unstratified sand, with boulders, local and travelled, and stones often striated and polished.	The Lower St. Lawrence region holds a few marine shells of Arctic species. Farther inland is non-fossiliferous, but has usually the chemical characters of a marine deposit.
(*d*) Lower Leda clay; fine clay, often laminated, and with a few large travelled boulders, probably equivalent to Erie clay[2] of inland districts.	Holds *Leda* (*Portlandia*) *arctica*, and sometimes *Tellina groenlandica*; and seems to have been deposited in very cold and ice-laden water.
(*e*) Upper Leda clay, and probably Sangeen clay[2] of inland districts; clay and sandy clay, in the Lower St. Lawrence, with numerous marine shells.	Holds in Eastern Canada a marine fauna identical with that of the northern part of the Gulf of St. Lawrence at present; and locally affords remains of a boreal flora.
(*f*) Saxicava sand and gravel, often with numerous travelled boulders (Upper Boulder deposit), probably the same with Algoma sand, etc., of the West.	Shallow-water fauna of boreal character, more especially *Saxicava rugosa* and its varieties. Bones of Whales, etc.
(*g*) Post-Glacial deposits, river alluvia and gravels, Peaty deposits, Lake bottoms, etc.	Remains of *Mastodon* and *Elephas*, modern fresh-water shells.

The Lower Boulder-clay (*c*) is often a true and very hard Till, resting on intensely glaciated rock-surfaces, and filled with stones and boulders. Where very thick, it can be seen to have a rude stratification. Even when destitute of marine fossils, it shows its

[1] Supplement to Acadian Geology, 1878. Notes on Post-Pliocene of Canada, Canadian Naturalist, vol. vi. 1871.

[2] Geology of Canada, 1863.

submarine accumulation by the unoxidized and unweathered condition of its materials. The striæ beneath it, and the direction of transport of its boulders, show a general movement from N.E. to S.W., or up the St. Lawrence Valley from the Atlantic. Connected with it, and apparently of the same age, are evidences of local glaciers debouching into the valley from the Laurentian highlands. The Boulder-clay of the basins of the great lakes, and of the western plains, and of the Missouri Coteau and its northern extensions, seems to be of similar character. The basins of the lakes are parts of old Pliocene valleys dammed up with Pleistocene debris.[1] The Missouri Coteau and its extensions, probably the greatest moraine in the world, and the "terminal moraine" of the great continental glacier of some American geologists, appears to be the deposit at the margin of a sea laden with vast fields of floating ice.[2]

The Lower Leda Clay (*d*) seems in all respects similar to the deposits now forming under the ice in Baffin's Bay and the Spitzbergen Sea. The Upper Leda Clay represents a considerable amelioration of climate, its fauna being so similar to that of the Gulf of St. Lawrence at present, that I have dredged in a living state nearly all the species it contains, off the coasts on which it occurs. Land plants found in the beds holding these marine shells are of species still living on the north shore of the St. Lawrence, and show that there were in certain portions of this period considerable land surfaces clothed with vegetation. The Upper Leda Clay is probably contemporaneous with the so-called inter-glacial deposits holding plants and insects discovered by Hinde on the shores of Lake Ontario.[3] On the Ottawa it contains land plants of modern Canadian species, insects and feathers of birds, intermixed with skeletons of of Capelin and shells living in the Gulf of St. Lawrence.

The changes of level in the course of the deposition of the Leda Clays must have been very great; fossiliferous marine deposits of this age being found at a height of at least 600 feet, and sea-beaches at a much greater elevation, while at other times there must have been large land areas and even fresh-water lakes. Littoral gravels and sands of this period may also be undistinguishable, except by their greater elevation, from those of the Saxicava sand. I have recently described the bones of a large whale (*Megaptera longimana*) from gravel north of the outlet of Lake Ontario and 420 feet above the level of the sea, which is not improbably contemporaneous with the Leda Clay of lower levels, and much higher than deposits near Lake Ontario regarded as of lacustrine origin.[4] These changes of

[1] Newberry, Reports on Ohio; Hunt, Canadian Reports; Spencer, Ancient Outlet of Lake Erie, Ann. Phil. Society, 1881.

[2] Report on 49th Parallel, G. M. Dawson.

[3] Proceedings of Canadian Institute, 1877. Dr. Hinde in this paper incorrectly states that the Leda Clay belongs to the "close of the Glacial Period," and that boulder drift is not found above it. In truth, as Admiral Bayfield, Sir Charles Lyell, and the writer have shown, boulder-drift is still in progress in the Gulf and River St. Lawrence, though in a more limited area than in the Post-Pliocene period; but any considerable subsidence of the land might enable it to resume its former extension.

[4] Canadian Naturalist, vol. x. No. 7.

the relative levels of sea and land must be taken into account in explaining the distribution of marine clays and sands, boulder deposits, etc., which are often regarded with reference to the present levels of the country, or as contemporaneous deposits without regard to their elevation, a method certain to lead to inaccurate conclusions.

The Saxicava Sand (*f*) indicates shallow-water conditions with much driftage of boulders, and probably glaciers on the mountains. It constitutes in many districts a second boulder formation, and possibly implies a somewhat more severe or at least more extreme climate than that of the Upper Leda Clay. Terraces along the coast mark the successive stages of elevation of the land in and after this period. There is also evidence of a greater elevation of the land succeeding the time of the Saxicava Sand, and preceding the modern era.[1]

It is well known that very diverse theoretical views exist among geologists as to the origin of the deposits above referred to. The conclusions which have been forced upon the writer by detailed studies extending over the last forty years, are that in Canada the condition of most extreme glaciation was one of partial submergence, in which the valleys were occupied by a sea laden with heavy field ice continuing throughout the summer, while the hills remaining above water were occupied with glaciers, and that these conditions varied in their distribution with the varying levels of the land, giving rise to great local diversities, as well as to changes of climate. There seems to be within the limits of Canada no good evidence of a general covering of the land with a thick mantle of ice, though there must at certain periods have been very extensive glaciers on the Laurentian axis and in the mountainous regions of the west.[2] It does not, indeed, seem possible that, under any conceivable meteorological conditions, an area so extensive as that of Canada, if existing as a land surface, should receive, except on its oceanic margins, a sufficient amount of precipitation to produce a continental glacier.

Details on some of the above-mentioned formations will be found in my "Notes on the Post-Pliocene of Canada," and a large amount of recent information exists in the Reports of the Geological Surveys of Canada, and in papers published in the Canadian Naturalist and Geologist.

[1] Supplement to Acadian Geology, 3rd edition, pp. 14, et seq.

[2] G. M. Dawson, Reports on British Columbia, and Superficial Geology of British Columbia, Journal Geol. Society, 1878.

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