

Upper contains large striated boulders; but the Lower, it is admitted, may possibly also contain large boulders, as it has not been excavated to any considerable depth. The most distinctive feature is that they are divided in places by a bed of sand and well-worn gravel. Mr. Mackintosh considers that these gravels were washed out of a pre-existing glacial clay, of which only hummocky patches remain<sup>1</sup> (Lower Boulder-clay), and their striæ effaced during an inter-glacial period, when the transportation of striated stones had ceased. Without discussing in detail the accuracy of Mr. Morton's description, which I submit does not produce a faithful impression of what actually exists, but rather records what exists in his own mind on the subject, I ask, is the foregoing evidence full enough, or of a nature to justify a careful geologist in accepting an interpretation of the Boulder-clay fraught with such tremendous consequences? For my part, candidly I think it is not, and until some upholder of the theory shows that the Lower Boulder-clay is either a subaerial deposit or contains fossils differing from those in the bed above, or offers any of the distinctive characteristics and continuity such as I have stated are necessary to constitute a geological subdivision, I cannot consider the evidence to be worth much. Looking at the question in a broad aspect, it also appears to me that any division founded as this primarily is on the separation of the Clay by sand and gravel involves, if applied over a wide area, a physical absurdity. Under what possible conditions could a period intervening between the deposition of two beds of clay be represented everywhere only by sands and gravels? If these were washed out of the pre-existing clay, as Mr. Mackintosh infers, what became of the much greater bulk of the clay in which they were imbedded? Where are the equivalent deposits of clay which would surely have representatives somewhere in the interglacial period?

So far as my experience goes, the marine Boulder-clay and sands of the lower plains—and none but marine beds have hitherto presented themselves to me—are from the base of red sand or rock on which they rest to the surface, but one great deposit containing local variations of such a puzzling character as to be interpreted differently by every observer, the supporters of the tripartite division being frequently quite at a loss as to which division the respective beds should be allocated.

BLUNDELLSANDS, LIVERPOOL.  
Nov. 9th, 1876.

T. MELLARD READE.

#### ON THE FORMATION OF GROUND ICE.<sup>2</sup>

SIR,—Relative to the formation of "Ground Ice," I have to offer the following theory. In order that this phenomenon may take place the water must be near the freezing-point. Then we have an analogous condition of things to that of the atmosphere when hoar frost is deposited upon the ground, trees and shrubs on account

<sup>1</sup> From Mr. Morton's description one would infer this deposit extended all over the dock.

<sup>2</sup> See Dr. Landor's paper on "Ground Ice," *GEOL. MAG.*, 1876, Decade II., Vol. III. p. 459.

of these objects radiating their heat more rapidly than the surrounding air, and because they are solid forms presented to a liquid at the moment of crystallization, the feathers of the hoar frost extending to windward as each particle of water is driven by the breeze and frozen upon it.

So in a stream of water at the freezing-point, the stones at the bottom no doubt radiate their heat more rapidly than the surrounding medium, and particle after particle of water assumes its crystalline form on coming in contact with the solid, thus forming tubular masses in the direction of the stream.

124, WINCHEAP, CANTERBURY.

S. GORDON McDAKIN.

PROF. NORDENSKIÖLD ON RECURRENT GLACIAL PERIODS.

SIR,—Prof. Judd has told us repeatedly of late, not without some flourish of trumpets, how completely Prof. Nordenskiöld has demolished Mr. Croll and his theory of the causes of glacial epochs. Now from my youth up I have been backward in my reading, and have had an unconquerable aversion to books, and never read anything myself, if I can get a kind friend to read it for me, and tell me what it is about. So I have not yet read Prof. Nordenskiöld;<sup>1</sup> Prof. Judd is evidently thoroughly well up in him, and he would be doing a great kindness to myself, and perhaps others who are equally ignorant and lazy, if he would send you a short article giving Prof. Nordenskiöld's facts and arguments. Prof. Judd says these do not support Mr. Croll's theories; but what I especially want to know is, whether there is anything in them that tells against the generally received views on the subject.

YORKSHIRE COLLEGE OF SCIENCE, LEEDS.  
Dec. 9th, 1876.

A. H. GREEN.

GLACIAL ORIGIN OF LAKES.

SIR,—I have to ask for space for a reply to the courteous letters of Mr. Bonney and of my friend Mr. Judd.

Mr. Bonney's letter is mainly explanatory of his position, which several circumstances—unnecessary to detail—combined to render somewhat ambiguous. I think comparison would tend to show that

<sup>1</sup> The paper by Prof. Nordenskiöld especially referred to by Prof. Judd, is "On the Former Climate of the Polar Regions," being an address by Prof. Nordenskiöld delivered at the Anniversary Meeting of the Royal Swedish Academy of Sciences, March 31, 1875, and translated and printed *in full* in the GEOLOGICAL MAGAZINE, 1875, Dec. II. Vol. II. p. 525. The passage quoted by Prof. Judd appears at p. 531, but the whole paper is well worthy of perusal; as is also his paper "On the Geology of Icefjord and Bell Sound, Spitzbergen," GEOLOGICAL MAGAZINE for 1876, pp. 16, 63, 118, 255. Perhaps Prof. Green will "get a kind friend to read them for him." Nordenskiöld's "Expedition to Greenland" also appeared in the GEOL. MAG., 1872, Vol. IX. pp. 289, 355, 409, 449, 516, and has some good materials in it bearing on the former climate and the extinct floras. Many of our readers, when oppressed with the wearisome effort to master the contents of our monthly issue, will cordially sympathize with Prof. Green, and wish for a mental digester and Assimilator (like the Artificial Stomach in the Loan Collection) into which, as into a "Papin's Digester," they might put their heavy reading, and so get therefrom the *extractum sensorum* in a concentrated form. Till this invention is patented, Prof. Green has hit upon a happy expedient: "Get a kind friend to tell you what it is about"!—EDIT. GEOL. MAG.