

my feeble powers of comprehension that all I can do is reverentially to take off my hat to these several gentlemen, and subside; maintaining, nevertheless, that the delineation given by Mr. Harmer and myself in 1871 of the beds of the Cromer Cliff is (subject to the clearing up of what may be involved in the unconformity in the midst of the Lower Glacial of the cliff at Hasborough, and eastwards of that place, to which we called attention by sections and remarks) quite correct, Mr. Reid's many subdivisions notwithstanding; as is also the age and position of the beds of the Cromer Cliff section, relatively to the chalky clay that we assigned to them. As regards the mode in which the morainic clay was laid over the sand, I have in a paper sent in to the Geological Society, and now awaiting its turn for reading, given my view.

SEARLES V. WOOD, jun.

#### DR. CROLL'S ECCENTRICITY THEORY.

SIR,—May I be allowed to suggest to Dr. Croll that he should offer some explanation how the glaciation of North America, as compared with that of Europe, is to be reconciled with his theory. The difference between the Eastern side of North America and that of the west of Europe is admitted to be the result of the ocean currents now existing; but the glaciation of the two regions was merely an equal increase of the cold in both, without change in their relative proportions; the same differences which now exist being shown by the limit to which glacial evidences extend in both regions to have obtained during that glaciation.

This, as I have on more than one occasion observed, appears to me to be a conclusive objection to Dr. Croll's theory, which he admits to be baseless unless there were a complete diversion of the warm ocean currents from the hemisphere glaciated; and its satisfactory removal would to my mind be worth any amount of those subtle reasonings on the physics of heat in which Dr. Croll is so fertile, but which seem to me to be obnoxious to the reproach often levelled at figures, viz. that they may be made to prove anything.

SEARLES V. WOOD, jun.

#### ECCENTRICITY AND GLACIAL EPOCHS.

SIR,—Dr. Croll in his article in February last speaks of an erroneous assumption, that if the annual receipt of heat be far more than sufficient to melt the annual snow-fall, then such snow must be melted.

He does not point out wherein the error lies, and I feel very doubtful whether I understand what he is referring to. The assumption, he says, is totally opposed to the known facts of Greenland. This statement seems rather too strong. He quotes Meech's calculation that the heat received there, neglecting that cut off by the atmosphere, is enough to melt 50 feet of ice. We must make allowance for the great thickness of air traversed by the sun's rays, and for the loss of heat by the great obliquity of reflexion. A very rude calculation, with no pretence to accuracy, brings out that these reduce the heat received by the ground, to sufficient for melting only some 16 feet of ice. Since to vaporize ice requires  $7\frac{1}{2}$  times as much heat as to melt it, this would dissipate by evaporation only little more than two feet

annually. But the annual precipitation amounts to one foot. If we suppose this to be formed during the winter, then the heat given off in winter by radiation is as much as would evaporate one foot.

Radiation goes on in summer as well as in winter, indeed more actively, as then temperatures are higher. This has to be compensated out of the heat then being received. Thus, out of the heat received during summer, as much as will evaporate more than one foot of ice is spent simply in replacing the heat being radiated away. The heat ultimately left will scarcely be sufficient to evaporate the one foot of ice which we had to account for. Thus even neglecting the effects of the fall of temperature far below freezing-point in winter, the interception of solar heat by fogs in spring, and other possible causes, it is still conceivable for the calculated heat to fall on Greenland, and yet not dissipate so much as the observed amount of ice.

The above calculation gives some idea of the diverse results which may be obtained when we reason on uncertain assumptions. The heat given off in forming a foot of snow or ice out of vapour, if applied to changing snow or ice back merely into water, would liquefy nearly eight times as much. Whether solar heat would melt or evaporate the ice into which it entered probably depends on the dryness or dampness of the air. This suggests, what I have often thought probable, that to know better the laws of winds might be very helpful in the study of Glacial Periods.

The suggestion of Dr. Roberts's lucid letter, that the heat disengaged in the formation of snow, being disengaged in the upper regions of the air, produces little effect at the ground, is well worthy of consideration. The same is probably true of rain, and over not merely Arctic regions but the whole surface of the globe. But to make this action available in support of the theory under discussion, we must show that its effect can be increased by increase of eccentricity. It is not sufficient to prove that it is intensified by rising temperatures, unless it also be shown not to be correspondingly enfeebled when they fall. This remark applies to many suggested actions. Eccentricity when it seems to throw a sword into one scale, often places in the other scale a shield.

E. HILL.

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#### THE KURILE ISLANDS.

SIR.—The following notes upon the Kurile Islands were obtained from Mr. J. Snow, a gentleman who has spent several summers cruising amongst this interesting group of volcanos, whilst engaged in otter hunting. I offer them to you as supplementary to what I wrote upon these islands myself in 1878 (see *GEOLOGICAL MAGAZINE*, Decade II. Vol. VI. pp. 337—348).

*Chirnoi Islands.*—On May 29th, 1879, smoke or steam was seen to be issuing from the northern of these two islands. It is possible that the eruption may have commenced before this date. On the 30th, at intervals of from  $\frac{1}{4}$  to  $\frac{1}{2}$  an hour, loud explosions were heard. During the night the mountain was seen to be covered with fire. The eruption seems to have formed a new point of land. On the island there are four cones, all of which give off steam. Of these four, the most northern