

is just now so occupied with "earth movements" of another kind that I am unable to marshal all the arguments on the other side. But I shall try to put the main points as clearly as I can.

I accept Mr. Wallace's correction of the word "grinding" as the best word to describe the action of glaciers. It is better than either "digging up" or "scooping." Many men who account for marine gravels on such places as Moel Trefan mountain-top by the action of glaciers, *must* conceive of glaciers as capable of digging out and lifting up. But I agree with Mr. Wallace that "grinding" down is the best expression for true glacier action. This is the *mode* of action; but what of the *cause* of the motion which effects the grinding? Are we agreed on this? Mr. Wallace does not explain his view on this point. I hold that the only cause of true glacier action is gravitation, and that masses of ice will not move at all, or exert any grinding action, except when impelled by gravity down gradients more or less steep. Even if they do mount up some slopes, it is only when they are violently pushed by other masses moving down slopes from behind them. If this be true, then glaciers will not tend to dig holes out of the flat bottoms of valleys. Mr. Wallace says they will, if they are exceptionally thick. This is very doubtful: and still more is it doubtful that they can dig holes of a very peculiar character, such as is now proved to be the character of Como and other lakes, with steep and sharp outlines, or with barriers left untouched. One single fact of this kind, if well ascertained, is quite enough to upset a great theory, because it may be sufficient to prove that at least *some* lake basins *cannot* have been made by glaciers. And if some have not, it is not certain that any have been made by glaciers alone.

The constant association of lake basins with glaciated countries is Mr. Wallace's grand argument. But it is explicable in the theory of earth movements quite as easily as on the theory of glacial action. Glaciated countries are generally hilly, or mountainous. If Mr. Wallace believes that all hills and valleys are due to superficial *sculpturing alone*, of course his argument is facilitated. But if hills and valleys are even in any measure due to earth movements—crummings of the surface—then the formation of lake basins is an inevitable necessity. Every hollow must become a lake basin which has no natural outlet except at a higher level than at its own bottom. Yet if there be such a thing as earth movements at all, it is in the highest degree improbable that they should have failed in numerous cases to occasion hollows in which water would accumulate.

Mr. Wallace's unbelief that any earth movements have taken place so lately in geological time as the glacial age—say 100,000 years ago—is a declaration that does indeed astonish me. I can understand great doubt and difficulty as to the extent of these movements. But that they have taken place to some extent very lately indeed is, in my opinion, demonstrable in the country in which I now write. There is one old sea beach on the Island of Jura where the stones as left by the surf are as bare of vegetation and as unaltered in forms which show surf action, as if the ocean had beat upon it last year. And this sea beach extends for miles at elevations varying from 120 to (I believe) 160 feet. If I am not mistaken, recent surveys of the great Canadian and American lakes have proved that they lie in hollows of crumpled and distorted land surfaces. The whole of Mr. Wallace's theory on this subject seems to me to be out of date. The distribution of boulders in the Highlands can, in my opinion, be accounted for in no other way than the transport of masses of stone on floating ice. But putting aside altogether this larger question, if a "great submergence," as one of the latest events in the glacial epoch, smaller elevations of the land are among the most certain of geological facts. But if so, we have lake-basins in all hilly countries easily explained. Very often the elevation of land to a very small extent indeed, if unequal, as it is sure to be more or less, would immediately cause lakes wherever a pre-existing valley had its lower end more tilted than its upper end. The 120 feet which is represented on the coast of Jura in this county is an elevation which would fill half of our glens all over the county with lakes unless it was an elevation perfectly equal along the whole of pre-existing contours. The co-existence of lake-basins with hilly and glaciated countries, therefore, admits of an easy explanation without attributing to ice a kind of action which has never been proved to exist at all. Hilly countries are *crumpled* countries, and slight increases or decreases of the same action must of necessity produce lakes.

Origin of Lake Basins.

WE may all thank Mr. Alfred Wallace for putting together so concisely the main arguments on which the glacial theory of the origin of all lake basins has had a wide acceptance. My time

Glaciers have, however, without doubt caused lakes in cases where they have dammed up the mouth of glens with detrital matter. The enormous masses of such matter which dam up the waters of the northern Italian lakes are most impressive. But it does not follow that the glaciers which left those great masses also scooped out the deep bed and rocky walls of the Lake of Como.

My own belief is that the great recency of large earth movements is one of the facts of geological science which has yet to be accepted ; and that the slowness with which it has made progress, or has even been overborne, is entirely due to very natural preconceptions and general assumptions about the stability of the earth surfaces, such as those which find expression in Mr. Wallace's very interesting and significant paper.

ARGYLL.

Inveraray, Argyllshire, March 11.

P.S.—Recent calculations in America seem to bring down the possible date of the close of the glacial epoch there to little more than 10,000 years.