

on the floor of the surrounding ocean, as is known to have been the case with the Isle Julia, near Sicily, the Kaimenis in the crater of Santorino, and other instances.

Professors Ramsay and Geikie both bear witness to the large proportion of the sedimentary strata of early geological ages within the British Isles, that owe their origin to the fragmentary ejections of submarine or insular volcanos, wholly independent of sub-aerial denudations. So too Mr. Darwin, in his work on South America, describes an immense geographical area east of the chain of the Andes, as composed in great part of conglomerates alternating with beds of lava, all ejected from submarine volcanos.

These various sources of sedimentary accumulation at the bottom of the ocean, if added together, may fairly be considered as productive in the course of ages, of an aggregate mass of strata fully equal to that derived from the contemporary denudation of the land; and this, if admitted, would at the least double the figures in Mr. Croll's estimates of the mean annual amount of sedimentary strata produced by all causes combined. I should be the last of all geologists to underrate the effects of sub-aerial denudation. But it seems to me impossible to ignore the fact that immense accumulations of sedimentary strata are, and have always been, in course of production beneath the sea-level, by processes from which sub-aerial agencies are wholly excluded.

COBHAM, *March 14th*, 1871.

G. POULETT SCROPE.

TERRACES OF NORWAY.

SIR,—Under this heading in your number for this month is a notice of a work by Professor Kjerulf. The Professor's facts accord exactly with the theory which I have had the honour to publish in your pages (*GEOLOGICAL MAGAZINE*, November, 1866, p. 519, and May, 1867, p. 1), and his theory would only differ from mine in this, that he supposes the alluviums of which the terraces are the remains to have been formed under a *permanent* "water-surface, which caused the materials washed down by the streams to be heaped up everywhere to the height marked out," p. 75; and I suppose them to be formed by deposit *on land* from repeated *temporary* overflows caused by rain or by melted snow which is frozen rain.¹ No one will dispute this as regards the marine alluvium of the Nile. It stands above the surface of the sea, and rises now by deposit from yearly overflow. But if the north of Africa were to rise ever so gradually, it would cause the Nile to *fall* into the sea. That is, directly as the rise of the land would be the fall of the river into the sea. Directly as its fall into the sea would be its power of deepening its channel. The river *would* deepen its channel, and a time would

¹ As I stated (*GEOLOGICAL MAGAZINE*, May, 1867, p. 2), the cause of every alluvium in the wide wide world is the stoppage of the lowering of the bed of the valley. The sea stops the lowering of the bed of every valley. Therefore the end of every valley next the sea is flat and alluvial.

come when it could no longer overflow its banks. It would then in floods tear its banks down instead of building them up, and the banks would recede from the river in the form of two parallel terraces. But when the river had cut its banks down to the level at which it could again overflow them, it would again deposit on them, and would form a new alluvium at the new level of the river. If the rising of the land continued, this new alluvium, like the old one, would recede as two parallel terraces; and so, step by step, would be formed, as long as the rising of the land continued, whether the rising was gradual or sudden. I have mentioned such terraces at Loch Ranza in Arran, in the *Athenæum*, 22nd July, 1865.

So far in reference to marine alluvial plains. With regard to inland patches of alluvial plains and their terraces, their formation has nothing to do with the rising of the land, and nothing to do with the comparative level of the sea and land. They result only from the different hardness of the different strata of the same valley. That is, directly as the strata are hard (owing to the retarding of atmospheric disintegration and erosion), the valley is narrow, and assumes the character of a gorge with falls or rapids in the river. Directly as the strata are soft, the valley is worn back wide and flat.¹ Rain floods checked at the gorge then overflow the flat, and deposit an alluvium, as the falls or rapids of the hard gorge or narrows sink from erosion, the bed of the river in the soft valley above sinks also, till a time comes when the river can no longer overflow the alluvium which it has formed. And the sinking of the bed of the river in the inland alluviums produces the same effects as the rising of the land does on the marine alluviums. That is, alluvium after alluvium is formed one below the other, and in succession driven back as parallel terraces against the hill-side.

If my theory is true, this must be going on now in Norway. That is, there must be alluviums (not "basins" or permanent "water-surfaces") forming now below the ancient terraces at the level at which each river overflows above each gorge or rapid. These actually progressing alluviums may be seen throughout nature. They may be seen in Lyell's engraving of the Parallel Roads of Glen Roy, in Lord Milton's and Cheadle's terraces of the Fraser river, *GEOLOGICAL MAGAZINE*, 1867, Vol. IV., p. 206, and in Hooker's terraces of the Yangma, *ibid.*, p. 208.

Doubtless your *MAGAZINE* will be seen by Professor Kjerulf. Will he do me the favour to state whether this is so or not?

GEORGE GREENWOOD, Colonel.

BROOKWOOD PARK, ALRESFORD,
10th February, 1871.

¹ This is what Mr. Mackintosh has called Colonel Greenwood's "Hard gorge and soft valley theory."