the glacier, extending, I think, not less than 400 or 500 feet up the hill-sides. Near a farm-house, about half a mile from Grange, are some scratched and rounded blocks, with several *blocs perchés*. On one of the former, a smoothed boss of slate, by the road side, the glacial *striae* may be seen arranged in parallel flutings pointing down the valley. These are crossed at an angle of about 45° by the cleavage planes, and the whole mass is traversed by two systems of joints, which intersect one another at about the same angle.

The soft slate of Skiddaw is unfavourable to preserving marks of glacial action, and, besides this, its southern face is too steep to have allowed of any great accumulation of snow. The ice-stream from the Derwent Valley would probably sweep under its cliffs, then no doubt streaked with *couloirs* of snow, towards Bassen-thwaite. The glacier, indeed, may possibly have divided, and an offshoot have extended some distance up the Greta, where it may have met the ice-stream from the vale of St. John. Near to Threlkeld station I saw, when leaving the district, a number of large blocks scattered over the slopes adjoining the railway, which, I think, could only have been deposited by means of ice. They may, perhaps, denote the position of the terminal moraine of the glacier which, after passing over Thirlmere, descended the vale of St. John.

These are all the notes which I was able to gather during my stay in the Lakes, but I have little doubt that a more careful examination would make it possible to map out approximately the glaciers which once filled the greater part of many valleys in the mountain districts of Cumberland and Westmoreland.

III.—THE TERRACES OF THE CHALK DOWNS.

By G. POULETT SCROPE, Esq., M.P., F.R.S., F.G.S., etc.

MR. MACKINTOSH (Vol. III., p. 69, and p. 155, of the *GEOL. MAG.*) adduces the preservation of numerous terraces on the hill-sides in the Cretaceous districts of 'Wilts. and Dorset,' as "evidence of limited subaerial denudation since those terraces were formed," for that they are "raised sea-beaches," he says, admits of no doubt.

I venture to say that a more preposterous idea has seldom been started for the confusion of geologists.

Being a Wiltshireman I am well acquainted with these terraces, which are not confined to the Chalk-hills, but are found also among the Oolitic Cotswolds, and many other formations, where the hill-slopes and the nature of the subsoil are favorable to their formation. And I have no hesitation in declaring them without exception of artificial origin, worn by the plough, at a time when these slopes were, if they are not still, under arable cultivation.

I had supposed this to be the generally received opinion, and, as such, hardly worth sustaining by argument, until the doctrine of

their being sea-worn cliffs, or raised beaches, dating from a time, therefore, when the vales and hills of England lay below the ocean, was put forward as a certain fact by Mr. D. Mackintosh. But since I am not aware that the precise mode of formation of these terraces (locally called *Linchets* or *Balks*) has been anywhere clearly explained, it may be worth while to take this opportunity for doing so.

Any one who lives in a neighbourhood where these banks occur may see them, if not in course of formation from their beginning, yet growing yearly before his eyes; that is to say, wherever the slope *above* the bank is under arable cultivation. In this case as the course of the plough almost always follows the more or less horizontal trend of the surface, which is always the direction of the banks, the ridge of soil raised by the mould-board of the plough has everywhere a tendency, through the action of gravity upon it, to fall down-hill, never upwards. This down-hill tendency of the disturbed soil is greatly assisted by the wash of heavy rains upon the sloping surface, and the result is that, year by year, the whole surface soil of the slope, when under continuous arable culture, is, slowly, indeed, but surely, travelling downwards, until it is stopped by some hedge, or wall, or bank, which limits in a downward direction the disturbing action of the plough. Hence it is that wherever a hedge or wall forms the lower limit of any arable surface, with a considerable inclination, an accumulation of mould or made earth will be found, often several feet in depth, and by that much elevated above the surface of the soil on the lower side of the fence. In the meantime the upper parts of the slope, losing their vegetable mould, get poorer and poorer, the plough works nearer the bone (as farmers say), and the soil is there only recruited by contributions levied from the subsoil or triturated rock beneath. The thrifty farmers of Devonshire therefore often employ their idle hands and teams in winter in digging out the soil that has descended to the bottom of their steep fields and carting it up to the top again—thus restoring the balance and maintaining the fertility of the upper portion.

But, it may be said, the ordinary *linchets* of the chalk-downs have no hedge or wall along their lower boundary, which might act as a material obstacle to the descent of the soil before it reaches the very bottom of the combe or vale. True; but though it might be said in reply that fences may formerly have existed there, it is in no degree necessary to suppose this in order to account for the origin of the banks. We know that in early times the arable lands of the greater part of England were held as in severalty by different tenants or owners. We know, too, that, on the arable Common-field system, nothing was more usual than for the same owner or occupier to possess and cultivate several distinct strips or breadths of land separated from one another by the lands of others. Let us assume that a hill-side in one of these terraced districts was held in three or four strips of land, lying one above the other, by distinct occupiers—the strips being, for the sake of convenience in ploughing, longitudinal in form, that is, having their greatest length in a horizontal or nearly horizontal direction, following the sweep of the hill-

side whether curved or straight. The boundary line between these several strips may have been originally only a mathematical one, connecting, say, two mere-stones, and yet a bank will soon have been formed along it. For each *upper* cultivator will naturally have taken care not to allow the soil of his strip to descend to fertilize his neighbour's below. He would draw the lower limit of his strip by a reversed furrow, throwing the last ridge of soil up-hill, and thus leaving a slight trench, sufficient, however, to stop the silt washed down from above, which consequently would accumulate there in a bed perhaps an inch or two only in depth. But the next year, or on the next ploughing, the process is repeated. The cultivator again purposely checks the descent of silt by a double boundary furrow; and by degrees a slight bank of earth is formed, which, in the progress of years, increases into a linchet or balk several feet in height, with a somewhat flattened terrace above. This is not mere theory. I have often watched the growth of such banks, and even witnessed their formation from the beginning. It is notable, indeed, with what rapidity they are produced. For instance, I own a steeply sloping field, which was formerly rough grass-land, having a hedge at its base with the usual bank of earth on the upper side raised some five feet above the level of the surface on the lower side. Along that upper side of the hedge runs a public footpath. I gave leave to my tenant to plough up the grass slope, which he has now done for about ten years past, and the result has been the formation of a new bank, or linchet, as it may be called, from two to three feet high, above the footpath which has remained unchanged at its original level. See the illustration below, where the dotted line represents a section of the surface before the plough had broken it up, the firm line, that of its present form; *a b* is the newly formed terrace,

b b the new balk or linchet, *c d* the older one, *c b* the footpath, *e e* the hedge. The bank and terrace *a b b* are of course composed of soil washed down from the upper slope in the manner above described in the course of ten years ploughing, and the undisturbed position of the footpath shows that the fence has had no influence in producing the bank, which can only have been formed by the gradual accumulation of the soil washed down from above in the lowest furrow turned by the plough above the path. The slight ridge of grass that would naturally grow up on the outward edge of this furrow would alone suffice to check the descent of the silt into the path, and cause it to settle above.

This, I have no hesitation in asserting, is the simple explanation

of the origin of the "thousands of raised sea-beaches, many of them only a few feet in height, which may be found in Wiltshire, Dorset, and other counties," according to Mr. D. Mackintosh (GEOL. MAG. Vol. III., p. 69). Were they raised sea, or, indeed, river-beaches, they would be found composed of shingle or rolled pebbles. If sea or river-worn cliffs, they would consist of chalk, or other rock *in situ*. But on the contrary, they will be found on investigation, I believe invariably, to be composed of made earth, or soil, such as would naturally result from the downward wash of the slopes above annually broken up by the plough through a series of years, and exposed to the influence of subaerial denudation, so that, in fact, these terraces brought forward by Mr. Mackintosh as 'proofs' of the impotence of rain in moulding the earth's surface, afford on the contrary very pregnant and convincing evidence of its power in altering the configuration of our hill-slopes within very recent and limited times.¹

IV.—REMARKS ON SOME "SARSSENS," OR ERRATIC BLOCKS OF STONE, FOUND IN THE GRAVEL, IN THE NEIGHBOURHOOD OF SOUTHAMPTON, HAMPSHIRE.

By Lieut.-Col. W. T. NICOLLS.

(PLATE XIII.)

MY knowledge and observation of facts are neither of them sufficient to enable me to determine the mode of deposit of these blocks in their present sites; probably they may have been glacially transported, at the same time with the gravel, to the places where they are now found; or, possibly, they, or some of them, may have been swept away from their original localities in the Tertiary formation, by a flood, or floods, general or partial.

I have taken specimens of only four of these blocks of stone: these are all similar in appearance, being of a small-grained, heavy, and whitey-brown saccharoid sandstone, two of the specimens contain small, partially rounded flint pebbles. There appears to me, to be no evidence of pluvial, or fluvial action in the deposit of these gravels and stones in the neighbourhood of Southampton, nor have I observed such gravels (high or low level, old or new) to have been laid bare, or denuded, by either of the above now existing causes.

The neighbourhood of Southampton, to the north or north-west, may at one time have been an estuary, but not the bed of a river; and the levels of the country around it, must have at that time stood generally lower relatively to the sea-line, than they now do, or the sea itself must have been, at least temporarily, higher, to admit of gravel having been deposited everywhere about it; and there might

¹ "This is well exemplified where a hill-side has been cultivated. Man, while he cultivated it, acted as the destroyer, and Rain only as a *carrier* to take away part of the soil that man had rooted up. If man ceases to cultivate that mountain side, Rain causes plants to grow," &c. [Extract from Mr. G. H. Kinahan's Letter, GEOL. MAG., Vol. III., No. 19, p. 46.—EDIT.]