



Campbell 2 of 9  
(1-28)





25.  
Sent Jan'y 20 (2)  
1873

J. R. Campbell

## GLACIAL DRIFT

2800 FEET ABOVE THE SEA.

[*Extracted from the GEOLOGICAL MAGAZINE, September, 1872.*]

*Published by TRÜBNER & Co., 8 and 60, Paternoster Row, London, E.C.*



## GLACIAL DRIFT OF THE CENTRAL PART OF THE LAKE DISTRICT, UP TO 2800 FEET ABOVE THE SEA.

By D. MACKINTOSH, F.G.S.

(Author of Articles on the Drifts of the Borders of the Lake District.)

**D**URING five and a half weeks' examination and study of the glaciated rock-surfaces and drifts of the south-central part of the Lake District, in June and July last, I was fortunate in meeting with many fresh and clear sections in diggings for house sites, drains, gravel-pits, tracks of unusually large rain-torrents, etc., which enabled me on some points to arrive at a more satisfactory classification of the drifts of the country than I had previously succeeded in devising.

*Traces of a Great Valley-ignoring Ice-stream.*—It was not long before I found myself constrained to return to the doctrine advocated in "Scenery of England and Wales"—namely that a stream of land-ice must once have assailed the central part of the Lake District from the N.N.W.,—a stream of sufficient thickness and possessed of sufficient force to enable it to march over the irregular plateau between the Stake pass and Dunmail Raise—to glaciare the valleys and ridges obliquely or directly across, from Far Easdale (if not from a more northerly latitude) to Morecambe Bay, and over a breadth of country extending from the upper part of the two Langdales and the Coniston Old Man in the west, to Kentmere in the east—the direction of the mammillation and primary striation within this district ranging between N. and N.W., the general direction being about N.N.W. This great ice-stream smoothed nearly all, if not all, the *roches moutonnées*, from the splendid series on the top of the ridge (up to 1700 feet)<sup>1</sup> between Easdale and Great Langdale, down to the bosses in the two Langdales, Grasmere, Easdale, Rydal, Ambleside, Windermere, and Old Man valleys, and those situated on the watershed between Windermere and Stavely, and to the S. of Windermere and Bowness. This valley-ignoring, or rather Lake-district-ignoring ice-stream (for it treated high ridges as subordinate obstructions), would appear to have ground down a great part of the country during its uphill, downhill, and across-dale progress.<sup>2</sup> But

<sup>1</sup> I found very distinct striæ pointing N.N.W. at a point more than 1600 feet above the sea on this ridge. Lower down, the direction of the rock-smoothing and striæ crosses the outlets of Easdale and Blind Tarns.

<sup>2</sup> This ice-stream must have so smoothed and rounded the cliffs and rocky projections as to prevent their shedding much scree-matter for a long time afterwards, and

the comparative absence of smoothed and glaciated stones at high levels, even where the *roches moutonnées* are strikingly developed, and the uniformly smooth (excepting where weathered) and curvilinear character of the *roches moutonnées*, would seem to indicate that the rocks were mainly ground down by grit adhering to the base of the ice, and that the large loose blocks the ice met with in its course were either reduced to finer matter or jammed up in abrupt recesses. If we except boulders more than nine inches or a foot in average diameter, not one stone out of ten in the Pinnel of the central parts of the Lake District is distinctly glaciated, whereas in the marine boulder and brick clays of Cheshire, at least one stone out of three is decidedly flattened, grooved, or scratched.<sup>1</sup> These facts would seem to show that floating coast-ice is the great glaciator of stones, while land-ice is the great grinder and smoother of solid rocks.

*Clay- and Gravel-Pinnel or Sammel.*—I have lately seen upwards of a hundred clean sections of this formation from 134 up to 2800 feet above the sea. It consists of clay, loam, or sand, intermixed with numerous stones from the size of a pin's head up to one foot or sometimes a foot and a half in average diameter, boulders of a larger size being very exceptional. The stones are nearly all more or less blunted, some of them considerably rounded, but most of them sub-angular. The stones chiefly lie or stand at various angles, but not unfrequently exhibit a tendency to a curved linear arrangement. We almost invariably find the stones less and less rounded the higher we ascend the hill-sides—a fact (as above hinted) not very easily reconciled with the idea of their having been distributed by the great ice-sheet which ignored hill and valley. In the two kinds of pinnel, the clayey ("waxy") and the sandy or gravelly, the stones are *similarly* distributed; and both kinds (but especially the latter) frequently present the appearance of being rudely stratified in the form of a series of curves or arches, occasionally varied by a rough interwedging of beds. The waxy pinnel often contains seams, beds, or pockets of sand.—Pinnel may be found in nearly all positions. It fills up crevices and recesses in the rocks, chokes up brook courses, clings to steep as well as gently-rising hill-slopes, and covers plateaux and broad ridges at various levels; but the greatest masses are associated with angular or mammillated rocky projections which would appear to have arrested it in its forward movement. In such positions it forms undulating terraces, and gently-swelling large oblong knolls which generally run along the sides or middle of the larger valleys, or diversify broad low-level passes. The colour of the pinnel is usually yellowish brown, sometimes grey, especially when dry.

if to this consideration we add the possible disappearance of glaciers from the larger valleys soon after the ice-sheet vanished from the immediately surrounding plains (for even the inner ends of these valleys often lie lower than the plains), we shall see reason for expecting to find comparatively little subaërial moraine-matter represented among the drifts of the Lake District.

<sup>1</sup> In some parts of the Lake District where the smaller stones are fine-grained and not very hard, the proportion exhibiting scratches is greater, but even then the stones are scarcely ever much flattened or regularly grooved.



*Pinnel on Helvellyn.*—On the W. side of a great part of Helvellyn there is a flat terrace which slopes transversely from about 1900 feet up to 2100 feet. It is more or less covered with drift, the greater part of which, I believe, is true pinnel. West of the top of Helvellyn, a steeper slope at a higher level runs up to 2800 feet, where a sudden rise of the ground marks its termination. At this point (which is only a few hundred yards from the top of the mountain) I was fortunate in finding a newly-cut drain apparently intended to divert a part of the water of the celebrated Brownrigg well to a mine at a lower level. Under a covering of stony loam I saw a clear section of typical clayey pinnel, and afterwards found pinnel in brook sections lower down, so that the upland extension of this deposit to at least 2800 feet above the sea may be regarded as certain. But as pinnel, especially clayey pinnel, could only have been formed directly or indirectly by ice-action, the former extension of either land or sea-ice (possibly both) to this great altitude can scarcely be doubted.

*Pinnel Hillocks and Surface Blocks.*—In inland valleys and upland cwms, on passes between hills, and on cols or depressed parts of ridges, the pinnel (containing many small blunted or slightly rounded stones, and some glaciated small boulders, but no large angular blocks) often surrounds or is associated with projecting bosses of rock, in the form of small detached or semi-detached hillocks, or groups of hillocks, as in Great Langdale, Upper Rydal, and Kentmere valleys, Easdale and Blind Tarn cwms (Grasmere), Dunmail and Kirkstone passes, etc. Clear sections of these abrupt hillocks<sup>1</sup> generally reveal as good pinnel as that composing the large gently-swelling knolls of the wider valleys, with this difference that the hillocks, or rather the hollows between them, are much more dotted with large angular blocks (including split blocks), which, however, are *confined* to the surface, or to a thin covering of loamy débris,<sup>2</sup> with the exception of a few connected with the underlying rocky nuclei. The surface-blocks are probably “droppings” from rafts of coast-ice, or from small icebergs (derived from high-level glaciers) which in general did not float very far before parting with their loads,<sup>3</sup> as these blocks are chiefly found in inland or upland districts at no very great distance from cliffs which break up into large fragments. At the mouths of cwms (as in the case of Coniston Low Water) on the sides of inland valleys (as near Seathwaite), there are often ridges, or rows of angular blocks, which are evidently the *subaërial* moraines of small *post-marine* glaciers, but they belong to a period distinct from that of the pinnel hillocks which most observers have mistaken for moraines. An eminent Scotch glacialist inclines

<sup>1</sup> I have examined about twenty sections of these pinnel hillocks, the two most complete being near Elterwater Village, and Dunmail Raise Cottage.

<sup>2</sup> This débris has partly determined the shape of the smaller and less regular hillocks.

<sup>3</sup> In some instances large surface blocks, as well as the smaller boulders imbedded in the underlying drift, must have been floated to great distances from the Lake District.



General Section of Drifts (Blue Clay omitted) from the Central part of the Lake District to the plains on the S. or W. 2. Pinnel or Sammel, graduating into Lower Boulder-clay outwards, 3. Stony Loam progressively replaced by stratified Sand and Gravel. 4. Upper or Brick-clay.

to agree with me in regarding such hillocks as a more abrupt form of Till or Boulder-clay knolls.

The red stony loam which generally (not always) covers the pinnel in the Lake District, is often the merely weathered part of the pinnel; but after a number of observations on hill-slopes, I could not give up the belief that the loam (especially where the imbedded stones are angular, and still more especially where the loam is associated with large angular blocks) is what Victor Hugo would call a "veritable construction." I now however believe that this stony loam is not the equivalent of the brick-clay of the plains of the N.W. of England, but that it is on the horizon of the part of the middle sand and gravel which is found on the hill-sides, or on the borders of the hills. That the eskers of Ireland and kames of Scotland were piled up during some part of the Middle Sand and Gravel Period can, I think, scarcely be doubted; and I now see reason for believing that the second submergence which I have supposed necessary for the accumulation of the upper or brick clay of the plains was of very limited extent, and that this clay seldom rises higher than 400 or 500 feet above the present sea-level—the boulder-clay at higher levels in Lancashire, Yorkshire, Cheshire, and the Welsh borders, being the equivalent of the pinnel of the Lake District.

The drifts of Scotland and the N.W. of England cannot, I believe, be correlated without regarding the English upper or brick clay (above which there are no eskers or kames) as the representative of the Scotch shelly clay. My pinnel may possibly represent both the till and boulder-clay of Mr. James Geikie; and the more ancient blue clay of the N.W. of England and Wales may be on the horizon of the lower or dark till of Swedish geologists.







