

GEOLOGY

How Scotland's Mountains Arose

"A Classic Of Science"

Archibald Geikie, Famous Scotch Geologist, Tells of the Shaping of His Rugged, Beautiful Country

THE SCENERY OF SCOTLAND viewed in Connexion with its Physical Geology. By Archibald Geikie. London and Cambridge, Macmillan, 1865.

WHEN WE begin to inquire into the origin of the present scenery of the country, we are soon taught that each hill and valley, each mountain and glen, has a twofold history. There is first the story of the formation of its component rocks, whether these have been laid down layer after layer as sand, gravel, or mud upon the bottom of a former sea, or piled up as shingle along an ancient beach, or drifted as the finest ooze over the bed of a lake; whether formed of decay of extinct forests, or from the gathered fragments of corals and shells; whether rolled along in the form of liquid lava, or thrown up in showers of volcanic dust and ashes. And after we have tried to trace out the succession of events imperfectly chronicled in the rocks, and have learnt, in so doing, how little we know, and how utterly beyond human realization is the vastness of the antiquity thus recorded, there still remains the story of those after changes, whereby the various rocks that were piled over each other came to be upheaved and carved into the present framework of the country. Between the time when the rocks were formed and that in which they were raised into the land on which our hills and valleys have been moulded, long millions of years must in many cases have passed away, during which metamorphism and other underground processes were at work; for when these rocks appeared in the light of day they were often vastly different from the original condition. Sand, silt, and mud had been changed into schist, slate, gneiss, and granite; and this not in mere local patches, but, as in the Highlands, over an area many thousands of square miles in extent.

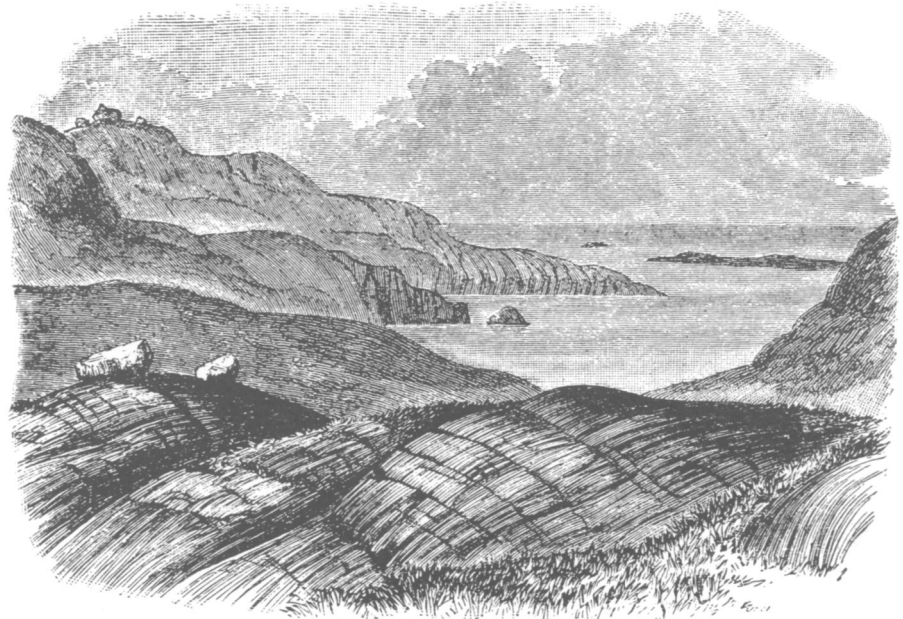
The hills and valleys of Scotland, we have seen, are not all of one age. They differ greatly also in geological struc-

ture, with a corresponding variety of scenery. As a convenient subdivision they were grouped into three districts—the Highlands, the Southern Uplands, and the Midland Valley. In taking leave of them, however, for the present, let us regard them finally as a whole, and picture briefly the changes by which their rocks, whether formed in lake, river, or sea, have come at last to wear their present outlines on the surface of the land. We watch them raised by subterranean movement within reach of the waves, and there for long ages.

Sea-Worn Platforms

"Swilled with the wild and wasteful ocean," until hundreds and thousands of feet of solid rock had been worn away. During possibly many risings and sinkings of the land this marine denudation went on, and by degrees the waves succeeded in levelling the country into broad undulating table-lands. It was out of such sea-worn platforms that the Scottish mountains and valleys appear to have been carved.

We mark how simply the present grouping of the valleys may have arisen. Rain falling on the land that was rising above the sea-level, found its way from the centre by devious paths outwards and downwards to the shore. These paths, once chosen, would ever be deepened and widened as century after century rolled away. The wide table-lands, like a sandy beach on the recession of the tide, were thus slowly hollowed out on every side by little runnels, that gathered into brooks, thence into larger streams, and lastly into broad rivers that swept the drainage out to sea. Year by year the process of excavation went on, every shower of rain, every spring, every frost, every stream contributing its share in the general waste. In the contemplation of such a history we are in a manner baffled and overawed by the vastness of the time which is required; the work accomplished is so vast, and the workers, even if we suppose that they once worked more rapidly and vigorously than they do now, seem so feeble. We may in imagination watch that ancient land for a thousand years, and yet detect no appreciable change upon its surface. We return to it after the lapse of a thousand centuries, and find per-



GLACIERS INVADDED SCOTLAND LEAVING LANDSCAPES LIKE THIS
From Geikie's famous Textbook of Geology, first edition, 1882; "Ice-worn surface of rock, showing polish, striae and groovings."

haps that the valleys are only a little deeper, and that the broad undulations between them begin to bear but a far-off resemblance to hills. At the end of another long interval, during which perchance the land has undergone not a few unequal upheavals and depressions, the hollows have sunk a little more. But how impossible to realize, even if we may yet be able to estimate, the time which was needed to change the ancient table-lands into a region of mountains and valleys; to excavate the wide straths and glens; to scarp the cliffs and precipices; to roughen the mountainsides with crag and scar and rocky pass; to dig the ravines and twilight gorges; and to carve out all that varied scenery which we know so well!

Perhaps it may yet be ascertained, that among the agents which in successive geological periods helped in no small degree to alter the surface of the globe were sheets of land ice and fleets of floes and bergs. There are indications of old glacial periods in Paleozoic, Secondary, and Tertiary times, and we may eventually learn that the glaciers and bergs of some of these remote ages took a part in carving out the valleys and planing down the table-lands of this country. But, be that as it may,

we know that the last great glacial period wrought marvellous changes upon the surface of the British Islands. In now glancing once more at the history of these changes, let us imagine the land, at the beginning of that period, rising into the same wide sweep of hill and valley as it does today. Gradually its plants and animals are displaced by those of more northern latitudes, as the temperature becomes year by year more wintry and ungenial. The snow creeps down from the hills, the forests and their inhabitants are pushed nearer and yet nearer to the sea; until at last, save perhaps in a narrow stripe along the shore in summer, one wide mantle of snow and ice has enveloped the land from the mountain peaks to the sea.

The Ocean Freezes

Still the cold increases. The very ocean freezes into solid sheets around the shores. The high grounds of the interior—higher, perchance, by several thousand feet, than they are today—receive a constant accession of snow, and the accumulated mass, pressing down the valleys, goes out to sea in long wide walls of ice. As it descends, year after year, and century after century, the surface over which it moves is ground and polished, the hardest rocks are shorn down, the ruggedness of the ancient land is largely worn off, countless lake-basins are excavated in the rocks, and an undulating outline is impressed upon the whole length and breadth of the country. The moraine-rubbish of this great ice-sheet gathers into the thick deposit known as *boulder-clay*. The summer, brief and feeble, has yet strength enough to melt the last winter's snow along the coast and in the maritime valleys; and doubtless, under the fading skirts of winter, the bright flowers of an Arctic type—saxifrages, ranunculi, willows, mosses, and the rest—spring rapidly into bloom. Nor are the larger mammals wanting; in such sheltered nooks the mammoth and the rhinoceros would find their appropriate food, as their survivors, the reindeer and the musk-ox, still do in the far north. The storms of summer work dire havoc on these shores for the groundswell, setting in strongly on the land, breaks up the coast-ice into heaps of ruin, which, laden with rocks and mud, are borne off, until they melt in mid-ocean or are stranded on other coasts.

The next act in this strange drama brings before us this ice-covered land slowly sinking beneath the sea. The higher mountain-tops, however, remain

"And he will stretch out his hand against the north and destroy Assyria; and will make Ninevah a desolation, and dry like a wilderness."
—Zephaniah. 2, 13.

LAYARD'S

Excavations at the Site of Ninevah

will be the

NEXT CLASSIC OF SCIENCE

above water, and send out their fleets of bergs and ice-rafts, for the climate is still severe enough to nourish on the narrowed land an abundant growth of ice and snow. Many a huge mass of granite or gneiss or schist is thus dropt quietly over the coal-measures of the Lothians; many a block of grit and greywackè is borne from the lonely islets of Lammermuir, Moorfoot, Dumfries, and Galloway, and sunk upon the hills and valleys of the north of England. Nay, large boulders of mountain-limestone are lifted from the coast-line skirting the half-submerged hills of Northumberland and Yorkshire, and scattered far and wide over the central counties. Even from the distant shores of Scandinavia bergs bring fragments of gneiss and granite to the plains of Central and Southern England. To this and the later parts of the history the upper boulder-clay and sandy drift are probably to be assigned. Moreover, the grating of these ice-islands over the sunken hills must doubtless have given rise to much abrasion of the solid rocks. Many a Scottish hill-top may thus have been smoothed and striated anew; and we probably see proof of the same process in the large number of scratched fragments of chalk from the Yorkshire Wolds in the boulder-clays of the east of England. The land once more begins to rise; the glaciers in the mountains of Wales, Cumberland, the south of Scotland, and the Highlands resume not a little of their former massiveness, as the country gathers increase of size.

Hills Clothed With Green

The sand and clay which the sea may have left behind it are by the ice cleared out of the glens. With the widening area of land, and the lessening severity of the climate, the hills and valleys, where free from perennial snow, are clothed with vegetation and haunted by



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beasts of the chase. By a succession of changes, as slow and silent, doubtless, as those which ushered in the Age of Ice, that long era begins to draw to a close. The glaciers feel the breath of a warmer clime coming over them, and shrink step by step back into the mountains, leaving, at every pause in their decline, great heaps of earth and rock—memorials, as it were, of their final and fruitless conflict with the adverse elements. But their doom has come, and the last lingering remnant of the old ice-sheet vanishes away. The very plants and animals of that cold period are involved in the same fate. Slowly and reluctantly they are driven from the lower grounds, as species after species makes its appearance from other lands, like the successive hordes of a conquering people. And now at last, on the bleakest and barest of our uplands, from which there is no escape, they carry on the struggle still. But the skirmishers of the invading army are amongst them, and the time will doubtless come when the ancient and Alpine races will disappear from our highest mountain-top, and with them the last living terrestrial relic of the great glacial period.

Since the ice melted away, the sea, rains, streams, springs and frosts have renewed their old work of demolition. The smoothed and flowing outline which the ice left behind it is now undergoing a slow destruction, and the rocks are quietly resuming the rugged outlines which they had of old. The sea-coasts are receding before the onward march of the waves; former ravines are deepened and widened by the rivers, and new ones have been formed. Man too has come upon the scene, and has set his mark upon well nigh every rood of the land from mountain-top to sea-shore. He has helped to demolish the ancient forests; he has drained innumerable fens and mosses, and turned them into fertile fields; he has extirpated the wild beasts of the old woods, thus changing both the aspect of the country and the distribution of its plants and animals. He has engraved the country with thousands of roads and railways, strewn it with villages and hamlets, and dotted it with cities and towns. And thus more has been done by him, in altering the aspect of the island, than has been achieved during the brief period of his sojourn by all the geological agencies put together.

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ZOOLOGY

Animals of Old West Will Get Chance to Stage Comeback

ANIMALS of the old West, the West of the covered wagon, will be given their chance to stage a comeback in territory that was theirs but where no living man has ever seen them. The three hundred mile strip of Mississippi bottom lands, set aside by Congress as a great game refuge, is to be stocked with bison, pronghorn antelope, elk and other hoofed and horned creatures that the redskins and earliest French traders knew a couple of centuries ago.

This promise was held out by Vernon Bailey, of the U. S. Biological Survey, at the meeting of the American Society of Mammalogists in Philadelphia last week. Mr. Bailey spent all of last summer in the region, studying its

present life and its possibilities for supporting representatives of its original population of wild things.

But last summer was by no means the first time he saw the area. He went there first in 1869, and on that occasion he travelled in a covered wagon.

Due For Radical Change

The region as it now stands consists of a strip of rich bottom land on either side of the Mississippi, subject to frequent floods, alternated with droughts. It is due for a radical change, said W. C. Henderson, also of the Biological Survey, if the present plans of the War Department are carried out. These plans call for the establishment of a nine-foot channel instead of the present six-foot one. This will mean the building of a series of about twenty dams, converting the river into a long line of stepped-up lakes, doing away with most of the current, establishing a stable water level and flooding some of the land permanently. On the whole, it will be a good thing for the wild life of both land and water, he believes.

Science News Letter, May 23, 1931

REFRIGERATION

One Chunk of Ice Lasts All Summer

REMINISCENT of the man who met the doctor's orders of "only one cigar a day" by buying stogies two feet long, is a new type of refrigerator recently built at Iowa State College, Ames, Iowa, by L. V. Crum of the physics department, which uses only one chunk of ice in a whole summer. The joker is, that this one chunk of ice is six feet high and six feet in diameter.

The new ice-box is a triumph of economy. Its first cost for materials is only \$50 to \$65, and its upkeep is nothing. It consists of two tanks, one six feet in diameter inside another one eight feet in diameter and nine feet high. Sawdust or similar material is used as insulation between the walls of the tanks. A cooling compartment is built under the center tank.

Ice is frozen in the winter in the inner tank, which is then covered with about sixteen inches of insulation also. The solid chunk of ice, six feet high and six feet in diameter, lasts from spring until September. In a test during the past year meat was kept during the summer for two weeks and apples were kept from spring to late summer in good condition.

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HEART OF ALL-YEAR ICE BOX

Frozen by spraying water on chicken wire. When completed it will be six feet in diameter.