

tiles, but which at the same time cannot be satisfactorily separated from similar underlying strata which contain Upper Old Red Sandstone fishes. There occur also below the Lias on some parts of the west coast unfossiliferous red sandstones, conglomerates, and breccias which may possibly belong to the same system. These rocks attain their greatest thickness at Gruinard Bay on the west coast of Ross, where they must be several hundred feet thick. On the east side of the country, where so many fragments of the Secondary rocks occur as boulders in the glacial deposits, a large mass of strata was formerly exposed at Linksfield near Elgin containing fossils which appear to show it to belong to the Rhaetic beds at the top of the Trias. But it was not in place, and was almost certainly a mass transported by ice. Rhaetic strata no doubt exist *in situ* at no great distance under the North Sea.

The Jurassic system is well represented on both sides of the Highlands. Along the east coast of Sutherland good sections are exposed showing the succession of strata. Among these the Lower and Middle Lias can be identified by their fossils. The Lower Oolite is distinguished by the occurrence in it of some coal-seams, one of which, $\frac{3}{4}$ feet in thickness, has been worked at Brora. The Middle Oolite consists mostly of sandstones with bands of shale and limestones and includes fossils which indicate the English horizons from the Kellaways Rock up to the Coral Rag. The lower part of the Kimmeridge Clay is probably represented by sandstones and conglomerates, forming the highest beds of the series in Sutherland. On the west side of the Highlands Jurassic rocks are found in many detached areas from the Shiant Isles to the southern shores of Mull. Over much of this region they owe their preservation in great measure to the mass of lavas poured over them in Tertiary time. They have been uncovered, indeed only at a comparatively recent geological date. They comprise a consecutive series of deposits from the bottom of the Lias up to the Oxford Clay. The Lower Middle and Upper Lias consist chiefly of shales and shelly limestones, with some sandstones, well seen along the shores of Broadford Bay in Skye and in some of the adjacent islands. The Lower Oolites are made up of sandstones and shales with some limestones, and are overlaid by several hundred feet of an estuarine series of deposits consisting chiefly of thick white sandstones, below and above which lie shales and shelly limestones. These rocks form a prominent feature underneath the basalt terraces of the east side of Skye, Raasay, and Eigg. They form the highest members of the Jurassic series, representing probably some part of the Oxford clay. The next Secondary rocks (Cretaceous) succeed them unconformably.

Cretaceous.

Rocks belonging to the Cretaceous system undoubtedly at one time covered considerable areas on both sides of the Highlands, but they have been entirely stripped off the eastern side, while on the western they have been reduced to a few fragmentary patches, which have no doubt survived because of the overlying sheets of basalt that have protected them. Some greenish sandstones containing recognizable and characteristic fossils are the equivalents of the Upper Greensand of the south of England. These rocks are found on the south and west coasts of Mull and on the west coast of Argyllshire. They are covered by white sandstones and these by white chalk and marly beds, which represent the Upper Chalk of England. Enormous numbers of flints and also less abundant fragments of chalk are found in glacial deposits bordering the Moray Firth. These transported relics show that the Chalk must once have been in place at no great distance, if indeed it did not actually occupy part of Aberdeenshire and the neighbouring counties.

Basaltic plateaus.

Above the highest Secondary rocks on the west coast come terraced plateaus of basalt, which spread out over wide areas in Skye, Eigg, Mull, and Morven, and form most of the smaller islets of the chain of the Inner Hebrides (GEOLOGY, vol. x. p. 362). These plateaus are composed of nearly horizontal sheets of basalt—columnar, amorphous, or amygdaloidal—which in Mull attain a thickness of more than 3000 feet. They are prolonged southwards into Antrim (Ireland), where similar basalts overlying Secondary strata cover a large territory. Occasional beds of tuff are intercalated among these lavas, and likewise seams of fine clay or shale which have preserved the remains of numerous land-plants. The presence of these fossils indicates that the eruptions were subaerial, and a comparison of them with those elsewhere found among older Tertiary strata shows that they probably belong to what is now called the Oligocene stage of the Tertiary series of formations, and therefore that the basalt eruptions took place in early Tertiary time. The volcanic episode to which these plateaus owe their origin was one of the most important in the geological history of Great Britain. It appears to have resembled in its main features those remarkable outpourings of basalt which have deluged so many thousand square miles of the western territories of the United States. The eruptions were connected with innumerable fissures up which the basalt rose and from numerous points on which it flowed out at the surface. These fissures with the basalt that solidified in them now form the vast assemblage of dykes which cross Scotland, the north of England, and the north of Ireland (GEOLOGY, vol. x. p. 312). That the

volcanic period was a prolonged one is shown by the great denudation of the plateaus before the last eruptions took place. In the Isle of Eigg, for example, the basalts had already been deeply eroded by river-action and into the river-course a current of glassy lava (pitch-stone) flowed. Denudation has continued active ever since, and now, owing to greater hardness and consequent power of resistance, the glassy lava stands up as the prominent and picturesque ridge of the Scur, while the basalts which formerly rose high above it have been worn down into terraced declivities that slope away from it to the sea. A remarkable feature in the volcanic phenomena was the disruption of the basaltic plateaus by large bosses of gabbro and of various granitoid rocks. These intrusive masses now tower into conspicuous groups of hills,—the Coolins in Skye, the mountains of Rum and Mull, and the rugged heights of Ardnamurchan.)

Under the Post-tertiary division come the records of the Ice Age, when Scotland was buried under sheets of ice which ground down, striated, and polished the harder rocks over the whole country and left behind them the widespread accumulations of clay, gravel, and sand known as glacial deposits. The nature of the evidence and the deductions drawn from it have been already stated (GEOLOGY, vol. x. pp. 365-368). The youngest geological formations are the raised beaches, river-terraces, lake-deposits, peat-mosses, and other accumulations, which are related to the present configuration of the country and contain remains of the plants and animals still living on its surface (GEOLOGY, vol. x. pp. 256, 290, 369).

PHYSICAL FEATURES.

The physical features of Scotland may be best realized by regarding the country as composed of three distinct belts of territory, differing from each other in their geological structure and consequently presenting striking contrasts in their scenery.

1. The Highlands, for convenience of description, are here regarded as embracing all that part of the country which lies west and north of a line drawn along the Firth of Clyde, and thence diagonally in a north-easterly direction from the mouth of the river Clyde to the east coast at Stonehaven. Nearly the whole of this region is high ground, deeply trenched with valleys and penetrated by long arms of the sea. The only considerable area of lowland lies in the north-eastern counties, embracing the eastern part of Aberdeenshire and the northern parts of Banff, Elgin, and Nairn. Along both sides of the Moray Firth a strip of lower land intervenes between the foot of the hills and the sea, while farther north the country of Caithness is one wide plain, which is prolonged into the Orkney Islands. Seen from beyond its southern margin, the area of the Highlands presents a well-defined chain of hills, which rise abruptly from the plains of the Lowlands. This is best observed in Strathmore, but it is also conspicuous in the estuary of the Clyde, where the low hills on the south contrast well with the broken line of rugged mountains to the north. From any of the islands of the chain of the Inner Hebrides the Highlands along their western sea-front rise as a vast rampart, indented by many winding fjords and rising up to a singularly uniform general level, which sinks here and there and allows glimpses to be had of still higher summits in the interior. The northern margin is hardly less striking when looked at from the Moray Firth, or from the plains of Caithness or Orkney.

From a commanding summit in the interior the Highlands are high seen to differ from a mountain chain such as the Alps, not merely land, in their inferior elevation, but essentially in their configuration and structure. They are made up of a succession of more or less nearly parallel confluent ridges, which have, on the whole, a trend from north-east to south-west. These ridges are separated by longitudinal valleys, and each of them is likewise furrowed by transverse valleys. The portions of ridge thus isolated rise into what are termed mountains. But all the loftier eminences in the Highlands are only higher parts of ridges along which their geological structure is prolonged. It is singular to observe how the general average of level of the summits of the ridges is maintained. From some points of view a mountain may appear to tower above all the surrounding country, but, looked at from a sufficient distance to take in its environment, it may be found not to rise much above the general uniformity of elevation. There are no gigantic dominant masses that must obviously be due to some special terrestrial disturbance. A few apparent exceptions to this statement rise along the western seaboard of Sutherland, in Skye, and elsewhere, but an examination of their structure at once explains the reason of their prominence, and confirms the rule.

The general surface of the Highlands is rugged. The rocks project in innumerable bosses and crags, which roughen the sides and crests of the ridges. The forms and colours of these roughnesses depend on the nature of the rock underneath. Where the latter is hard and jointed, weathering into large quadrangular blocks, the hills are more especially distinguished for the garbled bossy character of their declivities, as may be seen in Ben Ledi and the chain of heights to the north-east of it formed of massive grits and mica schists. Where, on the other hand, the rock decays into smaller débris, the hills are apt to assume smoother contours, as in

the slate hills that run from the Kyles of Bute to Loch Lomond. Wherever any mass of rock occurs differing much from those around it in its power of resisting decomposition it affects the scenery, rising into a prominence where it is durable, or sinking into lower ground where it is not. This relation between relative destructibility and external configuration is traceable in every part of Scotland, and indeed may be regarded as the law that has mainly determined the present topography of the country.

The Highlands are separated into two completely disconnected and in some respects contrasted regions by the remarkable line of the Great Glen, which runs from Loch Linnhe to Inverness. In the northern portion the highest ground rises along the west coast, mounting steeply from the sea to an average height of perhaps between 2000 and 3000 feet. The watershed consequently keeps close to the Atlantic seaboard, indeed in some places it is not more than a mile and a half distant from the beach. From these heights, which catch the first downpour of the western rains, the ground falls eastwards, but with numerous heights that prolong the mountainous character, to the edge of the North Sea and the line of the Great Glen. The best conception of the difference in the general level on the two sides of the watershed may be obtained by observing the contrast between the lengths of their streams. On the western side the drainage is poured into the Atlantic Ocean after flowing only a few miles, while on the eastern side it has to run at least 30 or 40. At the head of Loch Nevis the western stream is only 3 miles long; that which starts from the eastern side has a course of some 18 to the Great Glen. Throughout the northern or north-western region a general uniformity of feature characterizes the scenery, betokening even at a distance the general monotony in the structure of the underlying schists. But the sameness is relieved along the western coast of Sutherland and Ross by singular groups of cones and stacks (to be afterwards referred to), and farther south by the terraced plateaus and abrupt conical hills of Skye, Rum, and Mull. The valleys run for the most part in a north-west and south-east direction, and this is also generally true of the sea lochs.

The south-eastern region of the Highlands, being more diversified in geological structure, presents greater contrasts of scenery. In the first place, its valleys chiefly run in a south-west and north-east direction and so also do most of the lakes and sea lochs. This feature is strikingly exhibited in the western part of Argyllshire. But there are also numerous and important transverse valleys, of which that of the Garry and Tay is the most conspicuous example. Again, the watershed in this region is arranged somewhat differently. It first strikes eastward round the head of Loch Laggan and then swings southward, pursuing a sinuous course till it emerges from the Highlands on the east side of Loch Lomond. But the streams flowing westward are still short, while those that run north-east and east have long courses and drain wide tracts of high ground. The Tay in particular pours a larger body of water into the sea than any other river in Great Britain. Moreover, the occurrence of many bosses of granite and other eruptive rocks gives rise to various interruptions in the monotonous scenery of the crystalline schists which constitute the greater part of the country. But a marked contrast may be traced between the configuration of the north-eastern district and the other parts of this region. In that area the Grampians rise into wide flat-topped heights or elevated moors often over 3000 and sometimes exceeding 4000 feet in height and bounded by steep declivities or not infrequently by precipices. Seen from an eminence on their surface, these plateaus look like fragments of an original broad tableland, which has been trenched into segments by the formation of the transverse and longitudinal valleys. Farther to the south-west in Perthshire, Inverness-shire, and Argyllshire, they give place to the ordinary hummocky crested ridges of Highland scenery, some summits on which, however, exceed 4000 feet in elevation. For the probable meaning of this transition from broad flat-topped heights to narrow crests and isolated peaks, see below (pp. 525-526).

Besides the principal tracts of low ground in the Highlands already referred to, there occur numerous long but narrow strips of flat land in the more important valleys. Each strath and glen is usually provided with a floor of detritus which, spread out between the bases of the bounding hills, has been levelled into meadow-land by the rivers, and furnishes as a rule the only arable ground in each district.

2. The southern uplands form the most southerly of the three transverse belts in Scottish topography. Extending from St Patrick's Channel to St Abb's Head, they constitute a well-defined belt of hilly ground, but present a striking contrast to the scenery of the Highlands. The rocks which underlie them consist almost wholly of Silurian grits, greywackes, and shales, which have been greatly plicated, the general axis of the folds running parallel with that of the whole belt, or from south-west to north-east. These uplands, though much less elevated than the Highlands (their highest point is not more than 2764 feet above the sea), rise with scarcely less abruptness above the lower tracts that bound them. Their north-western margin for the most part springs boldly above

the fields and moorlands of the midland valley, and its boundary for long distances continues remarkably straight. Their southern and south-eastern limits are in general less prominently defined, except to the west of the Nith, where they plunge into the sea. Between the Solway Firth and the Cheviot Hills they pass under a line of high and picturesque escarpments which runs from Birrenswark in a north-east direction. In Berwickshire, however, they again tower boldly above the plain of the Merse. These uplands are distinguished above all by the smoothness of their surface. They may be regarded as a rolling tableland or moorland, traversed by innumerable valleys which with gentle verdant declivities conduct the drainage to the sea. This character is impressively seen from the heights of Tweedsmuir. Wide mossy moors, lying 2000 feet or more above the sea and sometimes level as a racecourse, spread out on all sides. Their continuity, however, is interrupted by numerous intervening valleys which separate them into detached flat-topped hills. Unlike the Highlands, these southern heights comparatively seldom present precipices of naked rock. Where the rock projects it more usually appears in low crags and knolls, from which long trails of grey or purple débris descend the slopes till they are lost among the grass. Hence, besides being smooth, the uplands are pre-eminently verdant. They form indeed excellent pasture-land, while the alluvial flats in the valleys and even some of the lower slopes of the hills are fitted for corn and green crops.

This uniformity of external aspect is doubtless traceable to the prevalence of the same kind of rocks and the same geological structure. The Silurian greywackes and shales that underlie almost the whole of these uplands weather generally into small angular structure débris, and at a tolerably uniform rate of disintegration. But slight differences may readily be detected even where no feature interferes in a marked way with the general monotony. The bands of massive grit and coarse greywacke, for example, break up into larger blocks and from their greater hardness are apt to project above the general surface of the other and softer rocks. Hence their line of trend, which like that of all the other strata is in a north-easterly direction, may be followed from hill to hill even at a distance by their more craggy contours. Only in the higher tracts of these uplands are any rugged features to be seen that remind one of the more savage character of Highland scenery. In the heights of Hartfell (2651 feet) and Whitecumb (2695), whence the Clyde, Tweed, Annan, and Moffat Water descend, the high moorlands have been scaped into gloomy corries, with crags and talus-slopes, which form a series of landscapes all the more striking from the abrupt and unexpected contrast they present to everything around them. In Galloway, also, the highest portions of the uplands have acquired a ruggedness and wildness more like those of the Highlands than any other district in the south of Scotland. For this, however, there is an obvious geological reason. In that region the Silurian rocks have been invaded by large bosses of granite and have undergone a variable amount of metamorphism which has in some places altered them into hard crystalline schists. These various rocky masses, presenting great differences in their powers of resisting decay, have yielded unequally to disintegration: the harder portions project in rocky knolls, crags, and cliffs, while the softer parts have been worn down into more flowing outlines. The highest summit in the south of Scotland—Merrick (2764 feet)—consists of Silurian strata much altered by proximity to the granite, while the rest of the more prominent heights (all in Kirkcudbrightshire)—Rinns of Kells (2668 feet), Cairnsmore of Carsphairn (2612), and Cairnsmore of Fleet (2331)—are formed of granite.

The watershed of the southern uplands is of much interest in Water relation to their geological history. It runs from the mouth of Loch Ryan in a sinuous north-easterly direction, keeping near the southern limit of the region till it reaches the basin of the Nith, uplands, where it quits the uplands altogether, descends into the lowlands of Argyllshire, and, after circling round the headwaters of the Nith, strikes south-eastwards across half the breadth of the uplands, then sweeps north and eastwards between the basins of the Clyde, Tweed, and Annan, and then through the moors that surround the sources of the Ettrick, Teviot, and Jed, into the Cheviot Hills. Here again the longest slope is on the east side, where the Tweed bears the whole drainage of that side into the sea. Although the rocks throughout the southern uplands have a persistent north-east and south-west strike, and though this trend is apparent in the bands of more rugged hills that mark the outcrop of hard grits and greywackes, nevertheless geological structure has been much less effective in determining the lines of ridge and valley than in the Highlands. On the southern side of the watershed, in Dumfriesshire and Galloway, the valleys run generally transversely from north-west to south-east. But in the eastern half of the uplands the valleys do not appear to have any relation to the geological structure of the ground underneath.

3. Between the two belts of high ground lie the broad lowlands Central of central Scotland, or the midland valley, bounded on the north lowlands, side by the range of heights that extends from the mouth of the

Clyde to Stonehaven, on the south side by the pastoral uplands that stretch from Girvan to Dunbar. The simplest conception of the general aspect and structure of this important part of the kingdom is obtained by regarding it as a long trough of younger rocks let down by parallel dislocations between the older masses of the high grounds to the south and north. The lowest of these younger rocks are the various sedimentary and volcanic members of the Old Red Sandstone. These are covered by the successive formations of the Carboniferous system. The total thickness of both these groups of rock cannot be less than 30,000 feet, and, as most of them bear evidence of having been deposited in shallow water, it is manifest that they could only have been accumulated during a prolonged period of depression. The question arises whether this depression affected only the area of the midland valley itself, or whether it extended also over the regions to the north and south. Materials do not yet exist for a definite answer to this question; but so far as the evidence now before us goes there is ground for the inference that, while the depression had its maximum along the line of the lowlands, it also involved some portion at least of the high grounds on either side. In other words, the Old Red Sandstone and Carboniferous rocks, though chiefly accumulated in the broad lowland valley, crept also over some part at least of the hills on either side, where a few outliers are left to tell of their former extension. The central Lowlands of Scotland are thus of great geological antiquity. During and since the deposition of the rocks that underlie them the tract has been the scene of repeated terrestrial disturbances. Long dislocations, running like the ridges of the Highlands and the southern uplands from south-west to north-east, have sharply defined its northern and southern margins. By other fractures and unequal movements of upheaval or depression portions of the older rocks have been brought up within the bounds of the younger, and areas of the younger have been enclosed by the older. On the whole, these terrestrial disturbances have followed the same prevalent north-easterly trend, and hence a general tendency may be observed among the main ridges and valleys to run in that direction. The chains of the Ochil, Sidlaw, Pentland, Benfrew, Campsie, and Fintry Hills, and the valleys of Strathmore, Firth of Tay, and the basin of Midlothian, may be cited as examples. But, undoubtedly, the dominant cause in the determination of the topographical prominences and depressions of the district has been the relative hardness and softness of the rocks. Almost the whole of the eminences in the Lowlands consist of hard igneous rocks, forming not only chains of hills like those just referred to and others in Ayrshire and Lanarkshire, but isolated crags and hills like those of Stirling Castle, Edinburgh Castle, and others conspicuous in the scenery of Fife and the Lothians.

Of the three chief valleys in the central Lowlands two, those of the Tay and the Forth, descend from the Highlands, and one, that of the Clyde, from the southern uplands. Though on the whole transverse, these depressions furnish another notable example of that independence of geological structure already mentioned.

We now proceed to consider the leading physical features of the country with especial reference to their distinctive aspects and their respective modes of origin. Though an eminently hilly country, Scotland is not dominated by any leading mountain chain on which all the other topographical features are dependent. Its leading features are not the monotonous ridges of the high grounds but the valleys that have been opened through them. If these valleys were filled up, the high grounds would once more become what they probably were at first, elevated plains or plateaus, with no strongly marked features,—no eminences rising much above nor hollows sinking much below the general surface.

Valleys.—Even apart from any knowledge of their origin, the valleys of the country are thus seen to be its fundamental topographical element, and to deserve the first consideration in any attempt to describe and explain its physical features. The longitudinal valleys, which run in the same general direction as the ridges—that is, north-east and south-west—have had their trend defined by geological structure, such as a line of dislocation (the Great Glen), or the plications of the rocks (Lochs Erich, Tay, and Awe, and most of the sea lochs of Argyllshire). The transverse valleys run north-west or south-east and are for the most part independent of geological structure. The valley of the Garry and Tay crosses the strike of all the Highland rocks, traverses the great fault on the Highland border, and finally breaks through the chain of the Ochil Hills at Perth. The valley of the Clyde crosses the strike of the Silurian plications in the southern uplands, the boundary fault, and the ridges of the Old Red Sandstone, and pursues its north-westerly course across the abundant and often powerful dislocations of the Carboniferous system.

That valleys are essentially due to erosion and not to dislocation or subsidence of the earth's surface is a fact which has now been demonstrated by so overwhelming a mass of evidence from all parts of the globe that it may be accepted as one of the axioms of geology. The plications of the earth's crust which folded the rocks of the Highlands and southern uplands not improbably upraised above the sea a series of longitudinal ridges having a general north-easterly

direction. The earliest rain that fell upon these ridges would run off them, first in transverse watercourses down each short slope and then in longitudinal depressions wherever such had been formed during the terrestrial disturbance. Once chosen, the pathways of the streams would be gradually deepened and widened into valleys. Hence the valleys are of higher antiquity than the mountains that rise from them. The mountains in fact have emerged out of the original bulk of the land in proportion as the valleys have been excavated. The denudation would continue so long as the ground stood above the level of the sea; but there have been prolonged periods of depression, when the ground, instead of being eroded, lay below the sea-level and was buried sometimes under thousands of feet of accumulated sediment, which completely filled up and obliterated the previous drainage-lines. When the land reappeared a new and independent series of valleys would at once begin to be eroded; and the subsequent degradation of these overlying sediments might reveal portions of the older topography, as in the case of the Great Glen, Lauderdale, and other ancient valleys. But the new drainage-lines have usually little or no reference to the old ones. Determined by the inequalities of surface of the overlying mantle of sedimentary material, they would be wholly independent of the geological structure of the rocks lying below that mantle. Slowly sinking deeper and deeper into the land, they might eventually reach the older rocks, but they would keep in these the lines of valley that they had followed in the overlying deposits. In process of time the whole of these deposits might be denuded from the area. The valleys would then be seen running in utter disregard of the geological structure of the rocks around them, and there might even remain no trace of the younger formations on which they began and which guided their excavation. This is probably the explanation of the striking independence of geological structure exhibited by the Tweed and the Nith.

Among the valleys of Scotland certain prevailing characteristics have been recognized in the popular names bestowed upon them. "Straths" are broad expanses of low ground between bounding ridges, hills usually traversed by one main stream and its tributaries.—Strath Tay, Strath Spey, Strath Conon. The name, however, has also been applied to wide tracts of lowland which embrace portions of several valleys, but are defined by lines of heights on either side; the best example is afforded by Strathmore—the "great strath"—between the southern margin of the Highlands and the line of the Ochil and Sidlaw Hills. This long and wide depression, though it looks like one great valley, strictly speaking, includes portions of the valleys of the Tay, Isla, North Esk, and South Esk, all of which cross it. Elsewhere in central Scotland such a wide depression is known as a "howe," as in the Howe of Fife between the Ochil and Lomond Hills. A "glen" is usually a narrower and steeper-sided valley than a strath, though the names have not always been applied with discrimination. Most of the Highland valleys are true glens. The hills rise rapidly on either side, sometimes in grassy slopes, sometimes in rocky bosses and precipitous cliffs, while the bottom is occupied by a flat platform of alluvium through which a stream meanders. Frequently the bottom of some part of the valley is occupied by a lake. In the south of Scotland the larger streams flow in wide open valleys called "dales," as in Clydesdale, Tweeddale, Teviotdale, Liddisdale, Eskdale, Nithsdale. The strips of alluvial land bordering a river are known as "haughs," and where in estuaries they expand into wide plains they are termed "carse." The carse of the Forth extend seawards as far as Borrowstonness and consist chiefly of raised beaches. The Carse of Gowrie is the strip of low ground intervening between the Firth of Tay and the line of hills that stretches from Perth to Dundee.

River-gorges are characteristic features in many of the valleys of Scotland. In the Old Red Sandstone they are particularly prominent where that formation has lain in the pathway of the streams sweeping down from the Highlands. In the basin of the Moray Firth some fine examples may be seen on the Nairn and Findhorn, while on the west side of the Cromarty Firth some of the small streams descending from the high grounds of the east of Ross-shire have cut out defiles in the conglomerate, remarkable for their depth and narrowness. On the south side of the Highlands still more notable instances of true "cañons" in the Old Red Sandstone are to be seen where the Erich, Isla, and North Esk enter that formation. The well-known gorge in which the Falls of Clyde are situated is the best example in the midland valley.¹

Types of Mountain and Hill.—While the topography of the country is essentially the result of prolonged denudation, we may reasonably infer that the oldest surfaces likely to be in any measure preserved or indicated are portions of some of the platforms of erosion which have successively been produced by the wearing away of the land down to the sea-level. Relics of these platforms seem to be recognizable both in the Highlands and among the southern uplands. Allusion has already been made to the remarkable flat-topped moorlands which in the eastern Grampians reach heights

¹ For the principal rivers, the Tay, Spey, Forth, Clyde, and Tweed, see the separate articles, and for the Dee (Aberdeen, Kirkcudbright), &c., see articles on the respective counties.

of 3000 to 4000 feet above the sea. Their most familiar example perhaps is the top of Lochnagar, where when the level of 3500 feet has been gained the traveller finds himself on a broad undulating moor, more than a mile and a half long, sloping gently southwards towards Glen Muick and terminating on the north at the edge of a range of granite precipices. The top of Ben Macdui stands upon nearly a square mile of moor exceeding 4000 feet in elevation. These mountains lie within granite areas; but not less striking examples may be found among the schists. The mountains at the head of Glen Esk and Glen Isla, for instance, sweep upward into a broad moor some 3000 feet above the sea, the more prominent parts of which have received special names.—Drieh, Mayar, Tom Buidhe, Tolmount, Cairn na Glasha. It would hardly be an exaggeration to say that there is more level ground on the tops of these mountains than in areas of corresponding size in the valleys below. That these high plateaus are planes of erosion is shown by their independence of geological structure, the upturned edges of the vertical and contorted schists having been abruptly shorn off and the granite having been wasted and levelled along its exposed surface. They look like fragments of the original tableland of erosion out of which the present valley-systems of the Highlands have been carved. Among the southern uplands traces of a similar tableland of erosion are in many places to be detected. The top of Broad Law in Peebleshire, for example, is a level moor comprising between 300 and 400 acres above the contour line of 2500 feet and lying upon the upturned edges of the greatly denuded Silurian grits and shales. An instructive example of the similar destruction of a much younger platform is to be found in the terraced plateaus of Skye, Eigg, Canna, Muck, Mull, and Morven, which are portions of what was probably originally a continuous plain of basalt. Though dating back only to older Tertiary time, this plain has been so deeply trenched by the forces of denudation that it has been reduced to mere scattered fragments. Thousands of feet of basalt have been worn away from many parts of its surface; deep and wide valleys have been carved out of it; and so enormously has it been wasted that it has been almost entirely stripped from wide tracts which it formerly covered and where only scattered outliers remain to prove that it once existed.

It is a curious fact, to which allusion has already been made, that broad flat-topped mountains are chiefly to be found in the eastern parts of the country. Traced westwards these forms gradually give place to narrow ridges and crests. No contrast, for instance, can be greater than that between the wide elevated moors of the eastern Grampians, and the crested ridges of western Inverness-shire and Argyllshire—Loch Hourn, Glen Nevis, Glencoe—or that between the broad uplands of Peebleshire and the precipitous heights of Galloway. No satisfactory reason for these contrasts can be found in geological structure alone. Perhaps the key to them is to be sought mainly in differences of rainfall. The western mountains, exposed to the fierce dash of the Atlantic rains, sustain the heaviest and most constant precipitation. Their sides are seamed with torrents which tear down the solid rock and sweep its detritus into the glens and sea lochs. The eastern heights, on the other hand, experience a less rainfall and consequently a diminished rate of erosion. There is no reason to doubt that the present preponderance of rainfall in the west has persisted for an enormous duration of time.

Regarding the existing flat-topped heights among the eastern Grampians as representing what may have been the general character of the surface out of which the present Highlands have been carved, we can trace every step in the gradual obliteration of the tableland and in the formation of the most rugged and individualized forms of isolated mountain. In fact, in journeying westwards across the tops of the Highland mountains we pass, as it were, over successive stages in the history of the origin of Highland scenery. The oldest types of form lie on the east side and the newest on the west. From the larger fragments of the denuded tableland we advance to ridges with narrow tops, which pass by degrees into sharp rugged crests. The ridges, too, are more and more trenched until they become groups of detached hills or mountains. In the progress of this erosion full scope has been afforded for the modification of form produced by variations in geological structure. Each ridge and mountain has been cut into its shape by denudation, but its actual outlines have been determined by the nature of the rocks and the manner in which they have yielded to decay. Every distinct variety of rock has impressed its own characters upon the landscapes in which it plays a part. Hence, amid the monotonous succession of ridge beyond ridge and valley after valley, considerable diversity of detail has resulted from the varying composition and grouping of the rocks.

The process by which the ancient tablelands of the country have been trenched into the present system of valleys and confluent ridges is most instructively displayed among the higher mountains, where erosion proceeds at an accelerated pace. The long "screes" or talus-slopes at the foot of every crag and cliff bear witness to the continual waste of the mountain sides. The headwaters of a river cut into the slopes of the parent hill. Each valley is consequently

lengthened at the expense of the mountain from which it descends. Where a number of small torrents converge in a steep mountain recess, they cut out a crescent-shaped hollow or half-cauldron, which in the Scottish Highlands is known as a "corry." Whether Corries the convergent action of the streams has been the sole agency concerned in the erosion of these striking concavities, or whether snow and glacier-ice may have had a share in the task, is a question that cannot at present be satisfactorily solved. No feature in Highland scenery is more characteristic than the corries, and in none can the influence of geological structure be more instructively seen. Usually the upper part of a corry is formed by a crescent of naked rock, from which long trails of debris descend to the bottom of the hollow. Every distinct variety of rock has its own type of corry, the peculiarities being marked both in the details of the upper cliffs and crags and in the amount, form, and colour of the screes. The Scottish corries have been occupied by glaciers. Hence their bottoms are generally well ice-worn or strewn over with moraine stuff. Not infrequently also a small tarn fills up the bottom, ponded back by a moraine. It is in these localities that we can best observe the last relics left by the retreat of the glaciers that once overspread the country. Among these high grounds also the gradual narrowing of ridges into sharp, narrow, knife-edged crests and the lowering of these into cols or passes can be admirably studied. Where two glens begin opposite to each other on the same ridge, their corries are gradually cut back until only a sharp crest separates them. This crest, attacked on each front and along the summit, is lowered with comparative rapidity, until in the end merely a low col or pass may separate the heads of the two glens. The various stages in this kind of demolition are best seen where the underlying rock is of granite or some similar material which possesses considerable toughness, while at the same time it is apt to be split and splintered by means of its numerous transverse joints. The granite mountains of Arran furnish excellent illustrations.

Where a rock yields with considerable uniformity in all directions the attacks of the weather it is apt to assume conical forms in the progress of denudation. Sometimes this uniformity is attained by a general disintegration of the rock into fine debris, which rolls down the slopes in long screes. In other cases it is secured by the intersection of joints, whereby a rock, in itself hard and durable, is divided into small angular blocks, which are separated by the action of the elements and slide down the declivities. In many instances the beginning of the formation of a cone may be detected on ridges which have been deeply trenched by valleys. The smaller isolated portions, attacked on all sides, have broken up under the influence of the weather. Layer after layer has been stripped from their sides, and the flat or rounded top has been narrowed until it has now become the apex of a cone. The mountain Schichallien (3547 feet) is a noble instance of a cone not yet freed from its parent ridge. Occasionally a ridge has been carved into a series of cones united at their bases, as in the chain of the Pentland Hills. A further stage in denudation brings us to isolated groups of cones completely separated from the rest of the rocks among which they once lay buried. Such groups may be carved out of a continuous band of rock which extends into the regions beyond. The Paps of Jura, for instance, rise out of a long belt of quartzite which stretches through the islands of Isla, Jura, and Scarba. In many cases, however, the groups point to the existence of some boss of rock of greater durability than those in the immediate neighbourhood, as in the Cuchullins and Red Hills of Skye and the group of granite cones of Ben Loyal, Sutherland. The most impressive form of solitary cone is that wherein after vast denudation a thick overlying formation has been reduced to a single outlier, such as Morven in Caithness and the two Ben Griams in Sutherland, and still more strikingly the pyramids of red sandstone on the western margin of Sutherland and Ross-shire. The horizontal stratification of some of these masses gives them a curiously architectural aspect, which is further increased by the effect of the numerous vertical joints by which the rock is cleft into buttresses and recesses along the fronts of the precipices and into pinnacles and finials along the summits. Solitary or grouped pyramids of red sandstone, rising to heights of between 3000 and 4000 feet above the sea, are mere remnants of a once continuous sheet of red sandstone that spread far and wide over the western Highlands.

Stratified rocks when they have not been much disturbed from their original approximate horizontality weather into what are called "escarpments,"—lines of cliff or steep bank marking the edge or outcrop of harder bands which lie upon softer or more easily eroded layers. Such cliffs may run for many miles across a country, rising one above another into lofty terraced hills. In Scotland the rocks have for the most part been so dislocated and disturbed as to prevent the formation of continuous escarpments, and this interesting form of rock-scenery is consequently almost entirely absent, except locally and for the most part on a comparatively small scale. The most extensive Scottish escarpments are found among the igneous rocks. Where lava has been piled up in successive nearly horizontal sheets, with occasional layers of tuff

or other softer rock between them, it offers conditions peculiarly favourable for the formation of escarpments. In the wide basalt plateaus of the Inner Hebrides these conditions have been manifested on a great scale. The Carboniferous lavas of the Campsie and Fintry Hills and of the south of Dumfriesshire and Roxburghshire likewise rise in lines of bold escarpment.

Lakes.—These important features in the landscapes of Scotland present the general characters of the water-basins so profusely scattered over the northern parts of Europe and North America. They may be classified in four groups, each of which has its own peculiar scenery and a distinct mode of origin—(1) glen lakes, (2) rock-tarns, (3) moraine-tarns, (4) lakes of the plains.

(1) Glen lakes are those which occupy portions of glens. They are depressions in the valleys, not due to mere local heaping up of detritus, but true rock-basins, often of great depth. Much discussion has arisen as to their mode of origin. They have been regarded as caused by special subsidence of their areas, open fissures of the ground, general depression of the central part of each mountain district from which they radiate, and by the erosive action of glacier ice. That they are not open fissures and cannot be explained by any general subsidence of a neighbouring region is now generally admitted. That glaciers have occupied the glens where these lakes exist and have worn down the rocks along the sides and bottom cannot be doubted, but whether the ice would be capable of eroding hollows so deep as many of these lakes is a question which has been answered with equal confidence affirmatively and negatively. On the other hand, to suppose that each of these hollows has been caused by a special local subsidence would involve a complex series of subterranean disturbances, for which some better evidence than the mere existence of the basins is required. Under any circumstances it is quite certain that the lakes must be of recent geological date. Any such basins belonging to the time of the plication of the crystalline schists would have been filled up and effaced long ago. So rapid is the infilling by the torrents which sweep down detritus from the surrounding heights that the present lakes are being visibly diminished, and they cannot, therefore, be of high geological antiquity. It is worthy of remark that the glen lakes are almost wholly confined to the western half of the Highlands, where they form the largest sheets of fresh water. Hardly any lakes are to be seen east of a line drawn from Inverness to Perth. West of that line, however, they abound in both the longitudinal and the transverse valleys. The most remarkable line of them is that which fills up so much of the Great Glen. Loch Ness, the largest, is upwards of 20 miles long, about 1½ miles broad, and not less than 774 feet deep in the deepest part. This great depression exceeds the general depth reached by the floor of the North Sea between Great Britain and the opposite shores of the Continent. Other important longitudinal lakes are Lochs Tay, Awe, Ericht, and Shiel. The most picturesque glen lakes, however, lie in transverse valleys, which being cut across the strike of the rocks present greater variety, and usually also more abruptness of outline. Lochs Lomond, Katrine, and Lubnaig in the southern Highlands, and Lochs Maree and More in the north, are conspicuous examples.

Rock-tarns.

(2) Rock-tarns are small lakes lying in rock-basins on the sides of mountains or the summits of ridges, and on rocky plateaus or plains. Unlike the glen lakes, they have no necessary dependence upon lines of valley. On the contrary, they are scattered as it were broadcast over the districts in which they occur, and are by far the most abundant of all the lakes of the country. Dispersed over all parts of the western Highlands, they are most numerous in the north-west, especially in the Outer Hebrides and in the west of Ross-shire and Sutherland. The surface of the Archaean gneiss is so thickly sprinkled with them that many tracts consist almost as much of water as of land. They almost invariably lie on strongly ice-worn platforms of rock. Their sides and the rocky islets which diversify their surface have been powerfully glaciated. They cannot be due to either fracture or subsidence, but are obviously hollows produced by erosion. They have accordingly with much probability been assigned to the gouging action of the sheets of land-ice by which the general glaciation of the country was effected. In the southern uplands, owing probably to the greater softness and uniformity of texture among the rocks, rock-tarns are comparatively infrequent, except in Galloway, where the protrusion of granite and its associated metamorphism have given rise to conditions of rock-structure more like those of the Highlands. Over the rocky hill-ranges of the central Lowlands rock-tarns occasionally make their appearance.

(3) Moraine-tarns—small sheets of water ponded back by some of the last moraines shed by the retreating glaciers—are confined to the more mountainous tracts. Among the southern uplands many beautiful examples may be seen, probably the best known and certainly one of the most picturesque being the wild lonely Loch Skene lying in a recess of Whitecomb at the head of the Moffat Water. Others are sprinkled over the higher parts of the valleys in Galloway. None occur in the central Lowlands. In the Highlands they may be counted by hundreds, nestling in the bottoms of the corries. In the north-western counties, where the

glaciers continued longest to descend to the sea-level, lakes retained by moraine-barriers may be found very little above the sea.

(4) The lakes of the plains lie in hollows of the glacial detritus which is strewn so thickly over the lower grounds. As these hollows were caused by original irregular deposition rather than by erosion, they have no intimate relation to the present drainage-lines of the country. The lakes vary in size from mere pools up to wide sheets of water several square miles in area. As a rule they are shallow in proportion to their extent of surface. Though still sufficiently numerous in the Lowlands, they were once greatly more so, for, partly from natural causes and partly by artificial means, they have been made to disappear. The largest sheets of fresh water in the midland valley are of this class, as Loch Leven and the Lake of Menteith.

Coast-Line.—The eastern and western seabords of Scotland present a singular contrast. The former is indented by a series of broad arms of the sea, but is otherwise tolerably unbroken. The land slopes gently down to the margin of the sea or to the edge of cliffs that have been cut back by the waves. The shores are for the most part low, with few islands in front of them, and cultivation comes down to the tide-line. The western side of the country, on the contrary, is from end to end intersected with long narrow sea lochs or fjords. The land shelves down rapidly into the sea and is fronted by chains and groups of islands. This contrast has sometimes been erroneously referred to greater erosion by the waves on the western than on the eastern coast. The true explanation, however, must be sought in the geological structure of the land. The west side of Scotland, as we have seen, has been more deeply eroded than the eastern. The glens are more numerous there and on the whole deeper and narrower. Many of them are prolonged under the sea; in other words, the narrow deep fjords which wind so far into the land are seaward continuations of the glens which emerge from their upper ends. The presence of the sea in these fjords is an accident. If they could be raised out of the sea they would become glens, with lakes filling up their deeper portions. That this has really been their history can hardly admit of question. They are submerged land-valleys, and as they run down the whole western coast they show that side of the country to have subsided to a considerable depth beneath its former level. The Scottish sea lochs must be viewed in connexion with those of western Ireland and of Norway. The whole of this north-western coast-line of Europe bears witness to recent submergence. The bed of the North Sea, which at no distant date in geological history was a land surface across which plants and animals migrated freely into Great Britain, sank beneath the sea-level, while the Atlantic advanced upon the western margin of the continent and filled the seaward ends of what had previously been valleys open to the sun. No improbably the amount of subsidence was greater towards the west.

Nearly the whole coast-line of Scotland is rocky. On the east side of the country, indeed, the shores of the estuaries are generally low, but the land between the mouths of these inlets is more or less precipitous. On the west side the coast is for the most part either a steep rocky declivity or a sea-wall, though strips of lower ground are found in the bays. The sea-cliffs everywhere vary in their characters according to the nature of the rock out of which they have been carved. At Cape Wrath precipices nearly 300 feet high have been cut out of the Archaean gneiss. The varying texture of this rock, its irregular foliation and jointing, and its ramifying veins of pegmatite conspire to give it very unequal powers of resistance in different parts of its mass. Consequently it projects in irregular bastions and buttresses and retires into deep recesses and tunnels, showing everywhere a ruggedness of aspect which is eminently characteristic. In striking contrast to these precipices are those of the Cambrian red sandstone a few miles to the east. Vast vertical walls of rock shoot up from the waves to a height of 600 feet, cut by their perpendicular joints into quadrangular piers and projections, some of which even stand out alone as cathedral-like islets in front of the main cliff. The sombre colouring is relieved by lines of vegetation along the edges of the nearly flat beds which project like vast cornices and serve as nesting-places for crowds of sea-fowl. On the west side of the country the most notable cliffs south from those of Cape Wrath and the Cambrian sandstones of Sutherland are to be found among the basaltic islands, particularly in Skye, where a magnificent range of precipices rising to 1000 feet bounds the western coast-line. The highest cliffs in the country are found among the Shetland and Orkney Islands. The sea-wall of Foula, one of the Shetland group, and the western front of Hoy in Orkney rise like walls to heights of 1100 or 1200 feet above the waves that tunnel their base. Caithness is one wide moor, terminating almost everywhere in a range of sea-precipices of Old Red Sandstone. Along the eastern coast-line most of the cliffs are formed of rocks belonging to the same formation. Beginning at Stonehaven, an almost unbroken line of precipice varying up to 200 feet in height runs southwards to the mouth of the estuary of the Tay. The southern uplands plunge abruptly into the sea near St Abb's Head in a noble range of precipices 300 to 500 feet in height, and on the western side the same high grounds

terminate in a long broken line of sea-wall, which begins at the mouth of Loch Ryan, extends to the Mull of Galloway, and reappears again in the southern headlands of Wigtown and Kirkcubright. One of the most picturesque features of the Scottish sea-cliffs is the numerous "stacks" or columns of rock which during the demolition and recession of the precipices have been isolated and left standing amidst the waves. These remnants attain their most colossal size and height on the cliffs of Old Red Sandstone. Thus the Old Man of Hoy in Orkney is a huge column of yellow sandstone between 400 and 500 feet high, forming a conspicuous landmark in the north. The coast of Caithness abounds in outstanding pillars and obelisks of flagstone.

The low shores on the west coast are not infrequently occupied by sand-dunes. Such accumulations fringe the western margin of North and South Uist, and are found in many bays from the north of Sutherland to the coast of Ayrshire. They are more abundant on the east coast, especially on the shores of Aberdeenshire, between the mouths of the two Esks, on both sides of the mouth of the Firth of Tay, and at various places in the Firth of Forth. Raised sea-beaches likewise play a part in the coast scenery of the country. These alluvial terraces form a strip of low fertile land between the edge of the sea and the rising ground of the interior, and among the western fjords sometimes supply the only arable soil in their neighbourhood, their flat green surfaces presenting a strong contrast to the brown and barren moors that rise from them. Most of the seaport towns of the country stand upon platforms of raised beach. Considerable deposits of mud, silt, and sand are accumulating in most of the estuaries. In the Tay, Forth, and Clyde, where important harbours are situated, considerable expense is involved in dredging to remove the sediment continually brought down from the land and carried backward and forward by the tides. Wide alluvial flats are there exposed at low water.

While no islands except mere solitary rocks like May Island, the Bass Rock, and Inchkeith diversify the eastern seaboard, the western side of Scotland presents a vast number, varying in size from such extensive tracts as Skye down to the smallest sea-stack or skerry. Looked at in the broadest way, these numerous islands may be regarded as belonging to two groups or series,—the Outer and the Inner Hebrides. The Outer Hebrides, extending from Barra Head to the Butt of Lewis, consist of a continuous chain of islands composed (with the exception of a small tract in the east of Lewis) entirely of Archaean rocks. Most of the ground is low, rocky, and plentifully dotted over with lakes; but it rises into mountainous heights in Harris, some of the summits attaining elevations of 2600 feet. The general trend of this long belt of islands is north-north-east. The Inner Hebrides form a much less definite group. They may be regarded as beginning with the Shiant Isles in the Minch and stretching to the southern headlands of Isla, the most important members being Skye, Mull, Isla, Jura, Rum, Eigg, Coll, Tiree, and Colonsay. The irregularity of this fringe of islands has no doubt been in chief measure brought about by its remarkable diversity of geological structure. Archaean gneiss, Cambrian sandstone, Silurian quartzite, limestone, and schist, Jurassic sandstone and limestone, Cretaceous sandstone, and Tertiary basalts, gabbros, and granitic rocks all enter into the composition of the islands.

Influence of topography on inhabitants.

Within the limits of this article it is only possible to allude to some of the more important influences of the topography on the history of the inhabitants. How powerfully the configuration of the country affects the climate is shown in the remarkable difference between the rainfall of the mountainous west and of the lowland east. This difference has necessarily affected the character and employments of the people, leading to the development of agriculture on the one side and the raising of sheep and cattle on the other. The fertile low grounds on the east have offered facilities for the invasions of Romans, Norsemen, and English, while the mountainous fastnesses of the interior and the west have served as secure retreats for the older Celtic population. While, therefore, Teutonic people have spread over the one area, the earlier race has to this day maintained its ground in the other. Not only the external configuration but the internal geological structure of the country has profoundly influenced the progress of the inhabitants. In the Highlands no mineral wealth has been discovered to stimulate the industry of the natives or to attract the labour and capital of strangers. These tracts remain still as of old sparsely inhabited and given over to the breeding of stock and the pursuit of game. In the Lowlands, on the other hand, rich stores of coal, iron, lime, and other minerals have been found. The coal-fields have gradually drawn to them an ever-increasing share of the population. Villages and towns have there sprung recently into existence and have rapidly increased in size. Manufactures have been developed and commerce has advanced with accelerated pace. Other influences have of course contributed largely to the development of the country, but among them all the chief place must undoubtedly be assigned to that fortunate geological structure which, amid the revolutions of the past, has preserved in the centre of Scotland those fields of coal and ironstone which are the foundations of the national industry. (A. GE.)

Climate.—In considering the climate of Scotland the first place must be assigned to the temperature of the various districts during the months of the year, it being this which gives the chief characteristics of climate and not the mean temperature of the whole year. Thus, while the annual temperatures of the west and east coasts are nearly equal, the summer and winter temperatures are very different. At Portree (on east coast of Skye) the mean temperatures of January and July are 39° and 56°·8, whereas at Perth they are 37°·5 and 59°·0. The prominent feature of the isothermals of the winter months is their north and south direction, thus pointing not to the sun but to the warm waters of the Atlantic as the more powerful influence in determining the Scottish climate at this season through the agency of the prevailing westerly winds. The Atlantic is in truth a vast repository of heat, in which the higher temperature of summer and that of more southern latitudes are treasured up against the rigours of winter; and in exceptionally cold seasons the ocean protects all places in its more immediate neighbourhood against the severe frosts which occur in inland situations. While this influence of the ocean is felt at all seasons, it is most strikingly seen in winter; and it is more decided in proportion as the locality is surrounded by the warm waters of the Atlantic. At Edinburgh the temperature is 27°·0 and at Lerwick 32°·5 higher than would otherwise be the case; in other words, but for the ameliorating influence of the Atlantic the temperature of Edinburgh in mid-winter would only be 12°·5 and of Lerwick 7°·5, or such winters as characterize the climates of Greenland and Iceland. The influence of the North Sea is similarly apparent, but in a less degree. Along the whole of the eastern coast, from the Pentland Firth southwards, temperature is higher than what is found a little inland to the west. The lowest temperature yet observed in the British Isles was -16°·0, which occurred near Kelso in December 1879. In summer, everywhere, latitude for latitude, temperature is lower in the west than in the east and inland situations. In winter the inland climates are the coldest, but in summer the warmest. The course of the isothermal lines at this season is very instructive. Thus the line of 59° passes from the Solway directly northwards to the north of Perthshire and thence curves round eastwards to near Stonehaven. From Teviotdale to the Grampians temperature falls only one degree; but for the same distance farther northwards it falls three degrees. The isothermal of 56° marks off the districts where the finer cereals are most successfully raised. This distribution of the temperature shows that the influence of the Atlantic in moderating the heat of summer is very great and is felt a long way into the interior of the country. On the other hand, the high lands of western districts by robbing the westerly winds of their moisture, and thus clearing the skies of eastern districts, exercise an equally striking effect in the opposite direction,—in raising the temperature.

There is nearly twice as much wind from the south-west as from the north-east, but the proportions vary greatly in different months. The south-west prevails most from July to October, and again from December to February; accordingly in these months the rainfall is heaviest. These are the summer and winter portions of the year, and an important result of the prevalence of these winds, with their accompanying rains, which are coincident with the annual extremes of temperature, is to imprint a more strictly insular character on the Scottish climate, by moderating the heat of summer and the cold of winter. The north-east winds acquire their greatest frequency from March to June and in November, which are accordingly the driest portions of the year.

The mountainous regions of Scotland are mostly massed in the west and lie generally north and south, or approximately perpendicular to the rain-bringing winds from the Atlantic. Hence the westerly winds are turned out of their horizontal course, and being thrust up into the higher regions of the atmosphere, their temperature is lowered, when the vapour is condensed into cloud and deposits in rain the water they can no longer hold in suspension. Thus the climates of the west are essentially wet. On the other hand, the climates of the east are dry, because the surface is lower and more level; and the breezes borne thither from the west, being robbed of most of their superabundant moisture in crossing the western hills, are therefore drier and precipitate a greatly diminished rainfall. It thus happens that the driest climates in the east are those which have to south-westwards the broadest extent of mountainous ground, and that the wettest eastern climates are those which are least protected by high lands on the west. The breakdown of the watershed between the Firths of Clyde and Forth exposes southern Perthshire, the counties of Clackmannan and Kinross, and nearly the whole of Fife to the clouds and rains of the west, and their climates are consequently wetter than those of any other of the eastern slopes of the country. The driest climates of the east, on the other hand, are in Tweeddale about Kelso and Jedburgh, the low grounds of East Lothian, and those on the Moray Firth from Elgin round to Dornoch. In these districts the annual rainfall for the twenty-four years ending 1883 was about 26 inches, whereas over extensive breadths in the west it exceeds 100 inches, in Glencroe being nearly 130 inches and on the top of Ben Nevis 150 inches. (A. B.)

PART III.—STATISTICS.

Population. Population; Vital and Social Statistics.—At the end of the 15th century it is supposed that the population of Scotland did not exceed 500,000,—Edinburgh having about 20,000 inhabitants, followed by Perth with about 9000, and Aberdeen, Dundee, and St Andrews each with about 4000. By the time of the Union in 1707 it is supposed to have reached 1,000,000, while according to the returns furnished by the clergy to Dr Webster in 1755 it was 1,265,380. At the time of the first Government census in 1801 it had reached 1,608,420. The increase through all the succeeding decades has been continuous, though fluctuating in amount, and in 1881 it had reached 3,735,573 (males 1,799,475, females 1,936,098),—an increase within the eighty years of 132 per cent. During the same period the population of England and Wales had increased 192 per cent., while the population of Ireland, owing to a rapid decrease since 1841, does not now differ greatly from what it was at the beginning of the century. The following table (I.) gives the areas of the various counties and of the whole of Scotland, the population in 1871 and 1881, the number of persons to the square mile of land-surface in the latter year, and the increase or decrease per cent. between 1871 and 1881:—

Table I: Population by County. Columns include County, Area in Acres, Population in 1871 and 1881, Pop. per Sq. Mile in 1881, and Increase or Decrease per cent. between 1871 and 1881. Total population in 1881 is 3,735,573.

Table II. (see below) affords a comparison of the numbers of the population in 1861, 1871, and 1881 as grouped in towns, villages, and rural districts. The returns do not afford a means of comparison between earlier years than those given. A striking fact deserving of mention is that in every county in Scotland the population increased between 1801 and 1841, the increase being more than

Table II: Population by Group. Columns include Groups, Total Population in 1861, 1871, and 1881, Increase or Decrease in 1861 to 1871, Increase or Decrease in 1871 to 1881, and Percentage to Total Population.

Table III: Population by Name. Columns include Name, Population in 1801, 1811, 1821, 1831, 1841, 1851, 1861, 1871, 1881, and Estimate 1883.

10 per cent. in each county, with the exception of Argyll, Perth, and Sutherland. The census returns for these years do not supply materials for an accurate estimate as to the increase of the purely rural or agricultural population, but it must have been considerable. Between 1841 and 1881 the following counties declined in population:—Argyll, Inverness, Kinross, Perth, Ross and Cromarty, Sutherland, and Wigtown,—all chiefly agricultural, and five of them in the Highlands, where much of the land was held by crofters. Only one county, Kinross, has a smaller population in 1881 than in 1801. Between 1851 and 1881 the island population, chiefly crofters, decreased by 4866, and the rural population between 1861 and 1881 by 125,583. In the following Highland counties the diminution in rural population between 1861 and 1881 was as follows:—Argyll from 60,109 to 46,081, Caithness from 28,279 to 24,309, Inverness from 74,439 to 67,855, Perth from 69,480 to 57,016, Ross and Cromarty from 59,147 to 49,832, and Sutherland from 21,560 to 18,696. In the total population of Scotland the rate of increase was considerably less between 1841 and 1881 than during the first forty years of the century,—42.5 to 62.9 per cent. The rates per cent. of increase in the several decades from 1801 have been as follows:—12.27, 15.82, 13.04, 10.82, 10.25, 6.972, and 11.18. The high rate of increase between 1871 and 1881 was due to an exceptional briskness of trade, and unless it has been maintained (which is not probable) the estimate of the registrar-general, which makes the population in 1885 number 3,907,736, must be regarded as much too sanguine. Table III. (see below) gives the population of the eight largest towns of Scotland at decennial periods since 1801. It is a curious fact that each of these towns has maintained its place in the "eight," although several towns now tread closely on the heels of Perth, whose rate of progress with that of Paisley has lagged greatly behind that of the other six.

While in England and Wales the number of persons to the square mile in 1881 was 452 and in Ireland 159, in Scotland the number was only 125. The small density of Scotland is due chiefly to the large proportion of mountainous land. In the north-western counties the density was only 23 to the square mile, in the northern 34, in the west midland 68, in the southern 68, while in the north-eastern it was 115, in the east midland 149, in the south-eastern 299, and in the south-western—Renfrew, Ayr, and Lanark—614. Table IV. (see p. 529) shows by the excess of births over deaths the increase that should have taken place between 1861 and 1871, and between 1871 and 1881 (but for the balance of emigration over immigration), compared with the actual increase, the grouping being into towns with over 25,000 inhabitants, towns between 10,000 and 25,000, towns under 10,000 and above 2000, and rural districts. It is impossible to make a comparison between 1861 and 1881 inasmuch as the proportion of large and small towns and rural districts has varied. It must also be explained that in comparing 1861 and 1871 the census of 1861 is taken as the authority for the grouping and in comparing 1871 and 1881 the census of 1871. This table shows in both decades an actual increase in the large and in the principal towns greater than that resulting from excess of births over deaths. It is the result not only of migration from the small towns and rural districts but of the immigration of English, Irish, and foreigners, and the return of natives of Scotland from abroad. By a comparison with Table II. it will be observed that the increase in the rural districts between the decades in Table IV. occurs only in the villages, and a closer examination of Table IV. further shows that any seeming increase is really delusive, and arises from the fact that there is no provision for the increase in

the number of small towns. Thus according to the grouping of 1871 the rural population of 1871 was nearly 28,000 less than the rural population of 1861 according to the grouping of 1861. It is from the villages and small towns that the large towns are principally recruited, the purely rural population preferring as a rule to emigrate.

Table V. shows the nationalities of the people of Scotland in 1871 and 1881, with the nationalities in 1881 in those burghs which had a population of 10,000 and upwards:—

Table V: Nationalities. Columns include Nationalities, Scotland 1871 (Number, Percentage to Pop.), Scotland 1881 (Number, Percentage to Pop.), and Burghs 1881 (Number, Percentage to Pop.).

This table indicates not merely an actual but a proportional increase in non-natives, there being an actual increase but a proportional decrease of natives of Ireland, and both an actual and a proportional increase of natives of England. Over the whole of Scotland the proportion of non-natives is a little over 9 per cent., while in the burghs it is nearly 13 per cent. The number of persons of Scottish birth in Ireland in 1881 was 22,328, and in England it was 253,528,—a total in the two countries of 275,856. On the other hand, the natives of the two countries in Scotland in 1881 were together 308,762, so that there is a smaller migration from Scotland to these countries than from these countries to Scotland.

The following table (VI.) shows the emigration of persons of Scottish origin from the United Kingdom at various periods since 1853:—

Table VI: Emigrants. Columns include Years (1853-55, 1856-60, 1861-65, 1866-70, 1871-75, 1876-80, 1881-85, 1883-85) and Emigrants (62,514, 59,016, 62,461, 85,621, 95,055, 70,596, 133,527, 568,790).

Comparing 1856-60 with 1881-85 it will be seen that the number of emigrants has more than doubled,—an increase of course proportionately much greater than the population. There are no statistics as to the number of immigrants into Scotland; and the significance of Table VI. is further lessened by the fact that it includes persons who may have been for some time resident in England or Ireland, or who may have been born there of Scottish parentage, and also supplies no information regarding emigration to the Continent. Only the principal ports, moreover, are included in the return.

The male population in 1881 was 1,799,475, an increase since 1871 of 12.2 per cent.; the female population 1,936,098, an increase of only 10.2 per cent. Since 1811, when there were 118.5 females to every 100 males, the proportion has been continuously diminishing, and in 1881 it was 107.6, but still greater than prevails either in England, which was 105.5, or in Ireland, which was 104.3. The proportion differs greatly in different counties, being as high as 134.71 in Shetland, chiefly on account of the number of males at sea. In Scotland the proportion of female births is smaller than that of male births: in 1885 it was 100 to 105; and males preponderate in the population up till the age of twenty-five, clearly showing that the excess of females is due to male emigration or the greater mortality of male occupations. The percentage

of illegitimate to the total number of births in 1855 was 7.8, and reached its maximum in 1865, when it was 10.2, while in 1885 it was 8.46. It is much higher in the lowland rural districts than in the Highland rural districts, and lowest in the large towns. The percentages of births, deaths, and marriages to population in the annual reports of the registrar-general are in a great degree misleading, inasmuch as the estimated population generally differs greatly from the actual. They place it, however, beyond doubt that the greatest birth, marriage, and mortality rates are in the town districts, that the smallest birth and marriage rates are in the insular districts, after which come the mainland rural districts, and that the mortality is not so high in the insular rural as in the mainland rural districts. Table VII. (see below) gives the percentage of single, married, and widowed to the total of each sex in Scotland, England and Wales, and Ireland respectively in 1881.

The number of blind persons in Scotland in 1881 was 3158 (males 1556, females 1602), the proportion to the total population being 1 in 1182 (males 1156, females 1208); the proportion in 1871 was 1 in 1112. The deaf and dumb in 1881 numbered 2142 (males 1149, females 993), the proportion to the total population being 1 in every 1744 as against 1 in every 1610 in 1871. The number of lunatics was returned as 8406 (males 3939, females 4467) or 1 in every 444 of the total population, the proportion in 1871 being 1 in every 494. In addition to this there were 5991 imbeciles (males 2896, females 3095), or 1 to every 623 of the population, the proportion in 1871 being 1 in every 727.

Table VIII. gives a classification of the population according to occupations in 1871 and 1881:—

Table VIII: Classes of Occupation. Columns include Classes of Occupation, 1871, 1881, and Per cent. of Total Pop. in 1871 and 1881.

It should be explained that the apparent diminution in the proportion of the unproductive class may be accounted for by the fact that in 1871 paupers were returned in this class, whereas in 1881 they were returned under the occupation at which they used to work. The increase in the proportion of the professional and commercial classes is at least a slight indication of higher average prosperity, but this is more conclusively established by the fact that the number of paupers has for many years been steadily on the decline, the proportion being now (1886) only 2.4 of the population. The average cost of maintenance is, however, on the increase, owing entirely to the increased cost of the maintenance of the lunatic poor.

Crime, like pauperism, is also steadily declining, as is shown Crime by Table IX.:

Table IX: Offences. Columns include Offences, Average (1836-40, 1851-55, 1875-79, 1880-84), 1884 (Males, Females), and Total.

TABLE IV.

Table IV: Population according to Grouping. Columns include Groups, Population according to Grouping in 1861 (1861, 1871), Population according to Grouping in 1871 (1871, 1881), Births (1861-71, 1871-81), Deaths (1861-71, 1871-81), Increase or Decrease from 1861 to 1871, and Increase or Decrease from 1871 to 1881.

TABLE VII.

Table VII: Sexes. Columns include Sexes, Scotland (Single, Married, Widowed), England and Wales (Single, Married, Widowed), and Ireland (Single, Married, Widowed).