times capping isolated mountains of red Torridon sandstone. They constitute the lowest group of the most interesting series of strata in the Highlands, and yield a large number of fossils. In descending order they embrace the following subdivisions, whose thickness in the district of Durness is estimated at about 2000 ft. : (e) limestones, dolomites and cherts, with numerous organic remains; (d) grit and quartzite, with Saltarella and Olenellus (Serpulite Grit) ; (c) calcareous shales and dolomites, with many annelid casts and sometimes Olenellus (Fucoid Beds) ; (b) Upper Quartzite, often crowded with annelid pipes (Pipe Rock Quartzite); (a) Lower Quartzite—their original upper limit can nowhere be seen, for they have been over- ridden by the Eastern Schists in those gigantic underground dis- turbances already referred to, by which these rocks, the Archean gneiss and Torridonian sandstone, were crumpled, inverted, dis­located and thrust over each other. The quartzites themselves have also been subjected to extraordinary horizontal displacement, amounting in places to not less than 10 m. The rocks overlying them to the east of the line of disturbance in the shires of Sutherland and Ross and Cromarty are fine flaggy schists. The Cambrian system— including the Upper (Durness-Eriboll Limestone) and the Lower (Serpulite grit, Fucoid Beds, Quartzite)—forms a narrow band which can be traced for 100 m. from the north coast of Sutherland to Skye. Rocks of Cambrian age have not been identified elsewhere in Scotland, though it may ultimately be shown that the quartzites and limestones of the Central Highlands are equivalents of those of the north-west coast.

Ordovician and Silurian.—-In the Southern Uplands a great development of Ordoviciar and Silurian rocks is found. In that belt they consist mostly of greywacke, grit, shale and other sedimentary rocks, but in the southwest of Ayrshire they include some thick lenticular bands of limestone. They have been thrown into many folds, the long axes of which run in a general north-easterly direction. It is this structure which has determined the trend of the southern Uplands. The plications of the Highlands and the chief dislocations of the country have followed the same general direction, and hence the parallelism and north-easterly trend of the main topographical features. Abundant fossils (grapholites principally) in certain parts of these rocks have shown that representatives of both the Ordovician and Upper divisions are present. By far the larger part of the Uplands belongs to the former. The Upper Silurian shales and sandstones appear only along the northern and southern margins. The coast on both sides of the country shows good sections of the rocks, the Berwickshire cliffs being particularly fine. Those of Ayrshire and Galloway are lower and more accessible, and permit of study of the plication of the strata. Among the best localities for fossils aye Moffat Water, in Dumfriesshire, for graptolites, and the Pentlands, in Midlothian. Balmae, on the southern shore of Kirkcudbrightshire, the coast south of Girvan and the limestone quarries of the Stinchar and Girvan valleys, in Ayrshire, for shells, trilobites, corals, &c.

Old Red Sandstone,—Scotland is the typical European region for the deposits classed as Old Red Sandstone. These rocks are grouped in two divisions, Lower and Upper, both of which appear to have been deposited in lakes. The Lower, with its abundant intercalated lavas and tuffs, extends continuously as a broad belt along the northern margin of the Central Plain, reappears in detached tracts along the southern border, is found again on the southside of the Uplands in Berwickshire and the Cheviot Hills, occupies a tract of Lome (Oban and the vicinity) in Argyllshire, and on the north side of the Highlands underlies most of the low ground on both sides of the Moray Firth, stretches across Caithness and through nearly the whole of the Orkney Islands, and is prolonged into Shetland. The Upper Old Red Sandstone covers a more restricted space in most of the areas just mentioned, its chief development being on the flanks of the north-eastern part of the Southern Uplands, where it spreads out over the Lammermuir Hills and the valleys of Berwick- shire and Roxburghshire. The Lower Old Red Sandstone is rich in remains of plants and fishes, notably in the flagstones of Caithness, Orkney and Forfarshire. The volcanic rocks of this division form ranges of hills in the Lowlands, such as the Pentlands, Ochils and Sidlaws. They have in some places a thickness of 7000 ft. The lavas are usually porphyrites, which occur in sheets, with intercalated bands of volcanic tuff that are sometimes strongly felsitic. One of the vents by which such materials were ejected occurs in the Braid Hills on the south side of Edinburgh. Fossils are less common in the Upper Old Red Sandstone, though they are found—particularly fishes—in large numbers in certain spots, as at Dura Den, near Cupar-Fife. Traces of contemporaneous volcanic action exist in the Orcadian island of Hoy.

Carboniferous.—The areas occupied by Carboniferous rocks are almost entirely restricted to the Central Plain or Lowlands, but they are also found skirting the Southern Uplands from the mouth of the Tweed to that of the Nith. In the basins of the Forth and Clyde the following subdivisions are well marked : (5) Upper Red Sandstone series (red and grey sandstones, fireclays, shales, marls); (4) Coal Measures (white and grey sandstones, dark shales, fireclays, coal seams, ironstones) ; (3) Millstone Grit (massive sandstones and grits, with fireclays, thin limestones and coal) ; (2) Carboniferous Limestone series—(r) sandstones and shales, with three or more seams of limestone; (b) sandstones, shales, coals and ironstones, but with no limestone bands; (a) sandstones, shales, fireclays, coals and iron­

stones, with thin limestones towards the top and the Hurlet (Renfrew­shire) limestone at the bottom; (1) Calciferous Sandstone series— (b) Upper or Cement Stone group, consisting of white and grey sandstones (of which the city of Edinburgh was built), black shales, thin limestones (Burdiehouse, near Edinburgh), and occasional coal seams; (a) Lower Red Sandstone group, with reddish and greenish marls and shales, passing down with the Upper Old Red Sandstone. The coal-fields contain two main groups of seams, the lower in the middle section of the Carboniferous Limestone, and the upper in the Coal Measures. The thin seams of the Calciferous Sandstone are not workable, but the bituminous shales in the Firth of Forth basin are largely worked for the manufacture of mineral oil. The plant-life of the Carboniferous was exceedingly luxuriant and varied, and the system is rich also in fossils of fishes, crustaceans, mollusca, insects and other forms of animal life. There was great volcanic activity during the deposition of the Calciferous. Sandstone, Carboniferous Limestone and Millstone Grit series. The two leading types of volcanic areas are the plateaus, in which sheets of porphyrites, basalts and even trachytes were emitted, sometimes with wide discharge of volcanic ashes, and the puys, or isolated vents, or scattered groups of vents, which discharged comparatively a small amount of lava and ashes. The Campsie, Kilpatrick and Dumbarton hills, the high ground from Greenock to Ardrossan, and the Carleton Hills in East Lothian are examples of the plateaus, while Arthur’s Seat in Edinburgh and the Binn of Burntisland illustrate the ρuys. Most of the hills and crags in the Carboniferous area are volcanic, and many of them—such as the castle rocks of Edinburgh and Stirling, Binny Craig in Linlithgowshire, North Berwick Law and the Bass Rock— mark the sites of actual events of eruption.

Permian,—Rocks assignable to the Permian system occupy only a few small areas in Scotland. They fill up the valley of the Nith for a few miles north of Dumfries, and, reappearing again in the same valley a little farther north, run up the narrow valley of the Carron to the Lowther HilIs. Other detached tracts cover a considerable space in Annandale, one of them ascending the deep defile, known as the Devil’s Beef Tub, at the head of that valley. Another isolated patch occurs among the Lead Hills; and lastly, a considerable space in the heart of the Ayrshire coal-field is occupied by Permian rocks. Throughout these separate basins the prevailing rock is a red sandstone, varied in the narrow valleys with intercalated masses of breccia. There can be no doubt that the valleys in which these patches of red rocks lie already existed in Permian time. They seem then to have been occupied by small lakes or inlets, not unlike fjords. Numerous amphibian tracks have been found in the red sandstone of Annandale and also near Dumfries, but no other traces of the life of the time. One of the most interesting features of the Scottish development of the Permian system is the occurrence of intercalated bands of contemporaneously erupted volcanic rocks in the Carron, Nithsdale and Ayrshire. The actual vents which were the sites of the small volcanoes still remain distinct, and the erupted lavas form high ground in the middle of Ayrshire.

Triassic.—The Triassic system is only feebly represented. The largest tract occurs in the south of Dumfriesshire between Annan and the head of the Solway Firth. To this division are assigned the yellow sandstones of Elgin, which have yielded crocodilian and other reptilian remains, the discovery of which led to the rocks being separated from the Upper Old Red Sandstone, to which they had previously been thought to belong. There occur also below the Lias on some parts of the west coast unfossiliferous red sandstones, con­glomerates and breccias, presenting lithological resemblance to the Rhaetic group of England. Such strata are well seen in the isle of Raasay and near Heast in Skye. Red sandstones and conglomerates, probably of the same age, attain a thickness of several hundred feet at Gruinard Bay on the west coast of the county of Ross and Cromarty. On the east side of Scotland, 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 to the north of 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 probably a mass transported by ice. Rhaetic strata no doubt exist in situ at no great distance under the North Sea.

Jurassic.—The Jurassic system—comprising, in descending order, the subdivisions of Upper Oolites (Portlandian Kimmeridge Clay), Middle Oolites (coal limestones; Oxford clay), Lower Oolites (Great Oolite series; Inferior Oolite series), Lias (Upper, Middle, Lower)— 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, 3½ ft. 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 largely to the mass of lavas poured over them in Tertiary time. They have been uncovered, indeed, only at a comparatively recent