6. Geology and Soil.

The rocks are the earliest history books that we have. To those who understand them they tell a fascinating story of the climate, the natural surroundings, and the life, of a time many millions of years before the foot of man ever trod this globe. They tell of a long succession of strange forms of life, appearing, dominating the world, then vanishing for ever. Yet not without result, for each successive race was higher in the scale of life than those that went before, till man appeared and struggled into the mastery of the world.

The most important group of rocks is that known as *sedimentary*, for they were laid down as sediments under

water. On the shores of the sea at the present time we find accumulations of gravel, sand, and mud. In the course of time, by pressure and other causes, these deposits will be consolidated into hard rocks, known as conglomerates, sandstones, and shales. Far out from shore there is going on a continual rain of the tiny calcareous

Types of Rocks—Sedimentary
(*Giffnock Sandstones*)

skeletons of minute sea-animals, which accumulate in a thick ooze on the sea-floor. In time this ooze will harden into a limestone. Thus by watching the processes at work in the world to-day, we conclude that the hard rocks that now form the solid land were once soft, unconsolidated deposits on the sea-floor. The sedimentary rocks can generally be recognised easily by their bedded

appearance. They are arranged in layers or bands, sometimes in their original, horizontal position, but more often tilted to a greater or less extent by subsequent movement in the crust of the earth.

We cannot tell definitely how long it is since any special series of rocks was deposited. But we can say with certainty that one series is older or younger than another. If any group of rocks lies on the top of another, then it must have been deposited later, that is, it is younger. Occasionally indeed the rocks have been tilted on end or bent to such an extent that this test fails, and then we must have recourse to another and even more important way of finding the relative age of a formation. The remains of animals and plants, known as fossils, are found entombed among the rocks, giving us, as it were, samples of the living organisms that flourished when the rocks were being deposited. Now it has been found that throughout the world the succession of life has been roughly the same, and palaeontologists (students of fossils) can tell, by the nature of the fossils obtained, what is the relative age of the rocks containing them. This is of very great practical importance, for a single fossil in an unknown country may determine, for example, that coal is likely to be found, or perhaps that it is utterly useless to dig for coal.

There is another important class of rocks known as *igneous* rocks. At the present time we hear reports at intervals of volcanoes becoming active and pouring forth floods of lava. When the lava solidifies it becomes an igneous rock, and many of the igneous rocks of this

country have undoubtedly been poured out from volcanoes that were active many years ago. In addition there are igneous rocks—granite for example—that never flowed over the surface of the earth in molten streams, but

Types of Rocks—Igneous

solidified deep down in subterranean recesses, and only became visible when in the lapse of time the rocks above them were worn away. Igneous rocks can generally be recognised by the absence of stratification or bedding.

Sometimes the original nature of the rocks may be

altered entirely by subsequent forces acting upon them. Great heat may develop new minerals, and change the appearance of the rocks, or mud-stones may be compressed into hard slates, or the rocks may be folded and twisted

Types of Rocks—Metamorphic

in the most marvellous manner, and thrust sometimes for miles over another series. Rocks that have been profoundly altered in this way are called *metamorphic* rocks, and such rocks bulk largely in the Scottish Highlands.

The whole succession of the sedimentary rocks is

divided into various classes and sub-classes. Resting on the very oldest rocks there is a great group called Primary or Palaeozoic. Next comes the group called Secondary or Mesozoic, then the Tertiary or Cainozoic, and finally a comparatively insignificant group of recent or Post-Tertiary deposits. The Palaeozoic rocks are divided again into systems, and since the rocks of Renfrewshire fall entirely under this head, we give below the names of the different systems, the youngest on top.

Palaeozoic Rocks.

Permian System.
Carboniferous System.
Old Red Sandstone System.
Silurian System.
Ordovician System.
Cambrian System.

The old rocks, particularly the Ordovician and the Silurian, are typical of the Southern Uplands, but we have already seen that Renfrew lies entirely in the Central Lowlands, and therefore these systems are not represented in the county. With the exception of a limited area where the Old Red Sandstone rocks are found, the rocks of Renfrew belong entirely to the Carboniferous system. The Old Red Sandstone rocks are confined to the south-west of the county, and can be particularly well seen along the shore from Wemyss Bay to Inverkip. They stretch inland on both sides of the county boundary and point a finger north-eastwards that almost reaches Loch

Thom. For the most part they are sandstones of a bright red colour, and have been quarried largely for building-stone. Almost all the houses in the locality have been built from the local Old Red Sandstone series.

The Carboniferous system is by far the most important in the county, for it occupies nine-tenths of the total area. Its sub-divisions are as follows:

Coal Measures.
Millstone Grit.
Carboniferous Limestone Series.
Calciferous Sandstone Series.

The true Coal Measures and the Millstone Grit[1] are not found in the shire, the geology of which is therefore seen to possess no great variety, although abounding in interesting and difficult problems. The Carboniferous Limestone series consists of sandstones, shales, limestones, coal-seams, and ironstones, and forms most of the lowlands in the east of the county. These rocks are not the true Coal Measures but they contain coal-seams of considerable value. All the coal worked in Renfrewshire comes from this series. The sandstones of the Carboniferous Limestone group furnish building-stone of the finest quality, and a large proportion of the city of Glasgow has been built from the sandstones found in the neighbourhood of Giffnock. The series falls into three

[1] The Geological Survey Maps show patches of Millstone Grit near Barrhead, but the lower boundary of that formation is now taken at the Castlecary Limestone instead of the Arden Limestone, and thus the rocks formerly classed as Millstone Grit become the top members of the Carboniferous Limestone series.

sub-divisions: (*a*) Upper Limestone Group, containing limestones and thick sandstones; (*b*) Middle Group, containing several workable seams of coal and ironstone associated with sandstones and shales, but not with limestones; (*c*) Lower Limestone Group, containing limestones and sandstones. The Giffnock Sandstones form a part of the Upper Limestone series which stretches north-east from the volcanic rocks near Barrhead, past Giffnock to Strathbungo, where a great fault occurs, on the other side of which the rocks have sunk till the Coal Measures have been brought level with the Carboniferous Limestones. Sandstone is the chief mineral obtained from these rocks, but here and there a coal-pit occurs working the coals of the Middle Group, and at one or two places, Darnley particularly, the limestones of the Upper Group are quarried.

The Calciferous Sandstone rocks consist largely of sandstones and shales, but the most remarkable feature of this period was the wonderful outbreak of volcanic activity that took place over most of the lowlands of Scotland. Hundreds of volcanoes burst into action, hurling forth stones and ash, while molten lava gushed from their craters, until in this way thousands of feet of rock were built up. From Stirling to Campbeltown these rocks are found, forming the Kilsyth Hills and the Campsie Fells, the Kilpatrick Hills, the Kilbarchan Hills, the Corkindale Moors, and the Eaglesham Moors, stretching thence along the borders of Lanarkshire and Ayrshire, and forming the high ground between these counties. The volcanic series is perhaps best developed in Renfrewshire,

and in certain parts of the county, notably in the hills round Misty Law, many of the vents from which the molten rock poured forth have been recognised.

These volcanic rocks are hard and resistant to the weather, and it is simply for this reason that they now form the hills of the county. They were poured out in great horizontal sheets, and this explains the plateau nature of the hills formed by these rocks. The series was not built up in a single outbreak. Eruption succeeded eruption, each pouring forth a new flow of lava. Thus the rocks were built up in a series of layers, and the resulting step-like outlines of the hills form one of the

Diagram showing effect on hill outlines of volcanic lavas overlying softer sedimentary rocks

most characteristic features of the scenery of the Clyde area. Looking from Ashton towards the ridge that terminates at the Cloch Point we see this well exemplified. On the left the junction between the lavas and the underlying sandstones is quite evident from the sudden steepening of slope that takes place there. On the sky-line the volcanic rocks are seen to descend in a series of steps, each step marking a different lava flow. In fact, wherever tabular hills assume this peculiar stepped profile, one may guess with some confidence that the hills are of volcanic origin.

Here and there throughout Scotland there occur isolated hills in the form of steep crags, of which the best known are Edinburgh Rock, Stirling Rock, and Dumbarton Rock. These hills are geographically and historically of the utmost importance, for, since the earliest times, they have formed strongholds on which castles were built, and round which in time busy towns grew up. Such a town—Dumbarton is an excellent example—owes its existence in every case to the fact that many ages ago, long before man appeared on the earth, a volcano happened to break forth and filled its chimney with solidified lava or hard, fragmentary rock. The surrounding softer rock was eroded more rapidly than the resistant volcanic material, and the denuded "neck" or "stump" of the old volcano remains as an isolated crag. Several examples of this type of hills occur in Renfrewshire. One of the best, although not on a very large scale, is the picturesque Craig of Carnock, near Barrhead. Neilston Pad, the hill that presents such a curious, artificial appearance, even when seen from as far off as Glasgow, has had a similar origin. The rock is of quite a different type from the surrounding lavas, and breaks through them in the same way as the more common neck pierces the surrounding sedimentary rocks. The rock composing Neilston Pad has been discovered to be a trachyte, a species hitherto entirely unknown in the west of Scotland[1].

[1] The discovery is due to Mr Tyrrell of Glasgow University. The results are not yet published, but the writer has been over the ground with Mr Tyrrell and has had the privilege of examining his micro-sections.

Volcanic activity in Renfrewshire manifests itself in still another way. At different periods in the earth's history, the solid crust has cracked along fissures, sometimes many miles in length, and up the crack has welled the molten lava, finally solidifying in a wall-like form called a dyke. These volcanic dykes are frequently harder

Volcanic Dyke at Ashton

than the surrounding rocks, and therefore stand up like artificial walls in a manner that eminently justifies the name. They are very plainly marked in the sandstones about Wemyss Bay, where the black bands of volcanic rock contrast strongly with the bright red colour of the surrounding sandstones. One of the largest can be seen

on the shore a mile south of Ashton where it forms a vertical wall over a dozen feet in height.

After the deposition of the Carboniferous rocks the geological history of Renfrewshire for many ages is a blank. If we compare the story of the rocks to a book of history, we may say that many of the later chapters of the work have been torn out and completely lost. Certainly many different systems were laid down on the Carboniferous rocks; doubtless the area was at times dry land, at times covered by the deep waters of the sea, but all the succeeding strata have been stripped away by those two all-powerful co-operators in destruction—time and the weather. The last chapter of the record tells us of the ice-age. For a long time the climate had been growing more severe. Tropical plants and animals were supplanted by temperate, and then by arctic, forms, and finally a great ice-sheet occupied all the higher parts of Scotland. Huge glaciers crept slowly down the valleys from their gathering grounds, the extensive ice-fields of the Highlands and the Southern Uplands. The glaciers have gone, but their work remains to tell their story—the grooves and scratches on the rocks, the excavation of lake-basins and the deepening of valleys, the moraines, well nigh as perfect now as when they were thrown down. The scratches on the volcanic hills make it plain that most of Renfrewshire was over-ridden by an ice-sheet that came from the north-west. Professor Gregory, however, has recently shown that in the Loch Libo Gap, during one period at any rate, there was a movement from south-west to north-east, and suggests that the glacier moving through the pass came

from the Hill of Stake region and was deflected to the north-east, or possibly came even from Arran. Sir Archibald Geikie, too, has recorded that pieces of Old Red Sandstone and other rocks found far to the south are occasionally met with in Renfrewshire, and explains this by an alternate advance of the ice from the Highlands southward, and from the Southern Uplands northward. The thick sheets of tough clay studded with boulders, found all over the county, are attributed to the ground-moraine of the great ice-sheet. During the melting of the ice, accumulations of sands and gravels were occasionally deposited. A fine series of such mounds is to be seen near Eaglesham.

At the close of the ice-age an event occurred of fundamental importance to the future welfare of the towns on the coastal fringe of Renfrewshire. This was a rise of the land or (we are not sure which) a withdrawal of the waters of the sea. This converted the old sea-beach into dry land, and thus formed a narrow band of low, flat ground round the coast, an eminently suitable site for watering-places. All the coast towns of the Firth of Clyde are situated on the "raised beach," and at most of them can be seen the old sea-cliff against which the waves once dashed, now left high and dry a few score yards inland. In Renfrewshire this can be well seen along the road between Gourock and Ashton. The road itself and all the houses next the sea are situated on the raised beach, which is flanked inland by low cliffs obviously of marine origin.

The volcanic rocks of the Renfrewshire hills abound

in rare minerals. Most of these are of interest chiefly to the mineralogist, but one or two are worth particular notice. Copper is found in more than one locality. In a whin-stone quarry near Barrhead, films and strings of metallic copper sometimes come to light, while the sandstones behind Gourock are impregnated with copper ore. The metal has even been mined in the volcanic rocks near Lochwinnoch. Fluor-spar, an exceedingly beautiful and somewhat uncommon mineral, is found in the county. It is familiar to many people as the "blue John" of Derbyshire, where the workers maintain with pardonable inexactitude that their mine is the only known locality for the mineral. Beautiful little crystals of a pale green or blue colour may still be obtained from the quarry in the igneous rocks behind Gourock. When the railway tunnel through the volcanic rocks at Bishopton was being made, minute crystals of an exceedingly rare mineral were discovered. The crystals are yellow and lustrous, and the largest are tiny pyramids a quarter of an inch high. The mineral received the name Greenockite after Lord Greenock, and some of the finest specimens are to be seen in the Hunterian Museum, Glasgow University.

The soil of the low parts of the shire is generally a rich alluvium which is capable of bearing heavy crops. Along the larger valleys also a fertile alluvial loam is found, although in places the lack of adequate drainage sours the soil, which is thus used only for grazing purposes. Over the volcanic rocks the soil is always very thin, the bare rock frequently protruding, except where sheets of boulder-clay occur. The thinness and the height above

sea-level of this soil prevent its use in agriculture, but in itself it is of considerable fertility. The course of a volcanic dyke, for example, can often be traced by the line of flourishing trees it carries. In many places the volcanic hills nourish a thick, springy turf, which when well cut forms the nearest approach to sea-side turf that can be found in any inland district. Thus golf courses have been instituted on the hill-sides (the Fereneze Club, the Cathkin Club, the Milngavie Club), the turf of which is much superior to that of the ordinary inland green, owing its excellence to the nature of the underlying rocks. In view of the enormous increase in the number of golfers in recent years, there is a hint here worthy the notice of the organisers of new courses.