dealt with, also poultry farming and pig-raising, which were, like the others, conducted on the co-operative system. Ventilation of byres, feeding to standard, and conservation of liquid manure by means of a tank under byre or stable, were also described. All this agricultural education and supervision cost money, and (according to the report of the Irish Commission) the taxation, local and national, on a farm of about 300 acres would run to nearly £100. He thought the people got value for it.

THE ROCKS OF BUTESHIRE.

By Mr James Kay.

[Read 9th February, 1909.]

The subject before us this evening is the Rocks of Buteshire, and refers more particularly to the specimens collected by me for the old Museum, top of Chapelhill—now over 30 years ago. Before referring more particularly to the specimens which form the subject of this paper, we shall give an outline of the physical features of the Islands which make up the County, viz.:—Bute, Arran, Holy Isle, Pladda, Meikle and Little Cumbrae, and Inchmarnock.

Bute is $15\frac{4}{16}$ miles long and from 2 to 4 miles broad, and has an area of 31,161 acres. The highest point (911 feet) is in North Bute, immediately above Stuck. Kames Hill, 875 feet, or 36 feet lower than that referred to; Kilbride Hill, 836 feet; Barone Hill, 530 feet; and Kilchattan Hill, 517 feet.

The north half of the Island—from Loch Fad—belongs to the slate formation. The southern portion of the Island consists of red sandstone overlaid in various parts by trap rock—as at Ascog Hill, Ambrisbeg, and the hills south of Kilchattan.

Inchmarnock is 2 miles long, greatest breadth, $\frac{6}{10}$ of a mile, and has an area of 675 acres. It is of the same formation as North Bute. The highest point is 165 feet.

ARRAN is 20 miles long and from $7\frac{1}{2}$ to 10 miles broad, and has an area, including Holy Isle and Pladda, of 103,953 acres. The northern half consists of a mass of peaked and rugged granite mountains, intersected by deep wild glens. The granite nucleus being everywhere enclosed by a narrow band of slate which is succeeded on the east and on the south by old red sandstone. The following are a few of the highest points in the northern half of Arran.—Goatfell, 2866 feet; Caisteal-abhail, 2735 feet; Ben Tarsuin, 2706 feet; north top of Goatfell, 2628 feet; Cir Mhor, 2618 feet.

The southern half of the Island is composed of several members of the Carboniferous series, which are broken through and overlaid by various Igneous Rocks. The highest points are Ard Bheinn, 1676 feet; Cnoc Dubh, 1341 feet; A Chruach, 1679 feet; Cnoc-na-brosie, 1346 feet, and so on.

Bryce, in his geology of Arran, remarks:—"The number of rock formations, sedimentary and plutonic, which are found within this limited space is truly remarkable, perhaps unparalelled in any tract of like extent on the surface of the globe."

Hedderwick further observes, that "in some respects Arran may be considered an epitome of the mineral structure of the globe." Thus we have the finest geological field to be found in the world at our very doors.

HOLY ISLE is $1\frac{9}{10}$ miles long by $\frac{6}{10}$ broad. Highest point 1030 feet. This Island is composed of claystone, with a sandstone base, which is seen in the north end of the Island.

PLADDA is a rocky islet attached to Arran by a whin dike consisting of a dark coloured trap.

GREAT CUMBRAE. This Island is $3\frac{8}{10}$ miles long by $1\frac{3}{4}$ broad, area 3121 acres. The highest point—"The Gledstone," 417 feet. It corresponds in geological structure with the

middle region of Bute, and is traversed by numerous trap dikes.

LITTLE CUMBRAE is $1\frac{8}{10}$ miles long, greatest breadth $\frac{9}{10}$ mile. Highest point, 409 feet. Area, 723 acres. In geological structure it corresponds with the southern divisions of Bute—from Kilchattan to Garroch Head.

In examining what is known as the crust of the earth—that is, the portion of the earth which is accessible to our observations, whether at the surface, or in caves, quarries, pits and mines—geologists have found that there are two great classes of rocks, one called Aqueous or Sedimentary, the other Igneous or those that have been formed through the agency of fire.

The Aqueous Rocks, as their name denotes, have resulted from the agency of water, in short, they are simply sediment which has been collected under water and deposited there layer after layer, just as gravel sand and mud are accumulated under water in every pool, river, lake and sea at the present day.

In times past, the greater part of the debris worn away by rain, springs, frosts, rivers and breakers from the surface of the land must have been laid under the sea. Hence by far the larger number of the subdivisions, into which the Aqueous or Sedimentary Rocks have been grouped, are of marine origin.

In the county of Bute we have most of the primary formations of the globe represented. Taking them in the order of their formation, the first is granite, which is represented by specimens from the top of Goatfell. Granite from Corrie shore, from Ploverfield, and fine-grained granite from Corrie shore.

The granites here referred to are considered to be nearly all of contemporaneous origin. Granite is the oldest rock,

having originally formed the crust of the earth. The word granite is derived from the Latin word granum, a grain. It consists of an aggregate of Quartz, Felspar and Mica.

Lyell, in his Elements of Geology, informs us that granite is supposed to have been formed at considerable depths in the earth where it has cooled and crystalised slowly under great pressure, and where the contained gases could not expand.

Granite usually forms what is called a mineral axis to which the lateral ridges on either side are subordinate and equally related.

In Arran, the granite does not absolutely form a mineral axis, but has been protruded close to the outer border of the two upper slates, so as almost to come in contact on the east side with the newer Sedimentary Strata. This singular abnormal position of the Arran granite was first pointed out by Dr M'Culloch.

Granite occurs in Arran in three disconnected tracts—amid the slates in the northern mountains, in the old red sandstone of Craig Dhu, and also amidst the Carboniferous Strata at Ploverfield.

In each of these positions it must be regarded as posterior to the rock which encircles it, since it is intruded among Sedimentary deposits, and produces a marked alteration upon them along the line of contact.

There are several varieties of both kinds, but these are merely dependent upon slight changes in the colour or size of the crystalline grains. The fine-grained has a different ring under the hammer, and affects the form of huge flat slabs or sheets rather than the massive rhombic block form of the course grained granite so well seen in the Cyclopean walls of

Goatfell. About 20 courses of huge slabs are here piled above each other, forming a lofty precipice.

The following are the analysis of the Felspar of the cross-grained granite:—

Silica, ...	63·70
Alumina, ...	20·02
Potash, ...	12 33
Soda, ...	1·71
Oxide of Iron, ...	1·28
Lime, ...	0·89
Magnesia, ...	Trace.
	99·93

A great number of granite boulders are dispersed over the Island of Arran, though they are most abundant and largest near the granite centre as about Corrie and Corriegills shores. They are also found on Holy Isle.

It is somewhat remarkable how they have got there. Various theories have been set forth as to the agency which transported these large boulders—such as the convulsions when Goatfell shook his giant sides, or the agency of ice and water. The most probable is that they have been carried through the agency of ice.

One of these remarkable boulders lies on the Corriegills shore. The base measures 21 feet by 12 feet, height 15 feet, and is supposed to weigh upwards of 210 tons.

One of the largest blocks on the Corrie shore, north of White Water glen, is estimated at 2000 tons. Another large block, standing upright on its apex, can be made to oscillate slightly as a rocking stone.

At one time many of these boulders were used in the Glasgow potteries for grinding flints.

Next specimen is part of a granite or Syenite boulder found on the farm of Barone Park. This boulder must have been carried from the north during the ice period, as there is no granite of a similar nature nearer than the head of Loch Awe.

Syenite derives its name from the city of Syene, in Egypt, where the most perfect type of it is found.

In Syenite, part of the Mica which enters into the composition of granite is replaced by Hornblende, which, with the rose-coloured Felspar of which this kind of rock is often made up, forms a valuable stone for architectural ornament.

Hornblende is a mineral of a dark green colour, abounding in Oxide of Iron. It consists of Silica, Magnesia, Lime, Alumina, Peroxide of Iron and Fluoric Acid, and scratches glass.

We now come to the *Slate Rocks* which are represented by specimens from Goatfell, Clay Slate from North Bute, also three specimens of contorted Mica Schist from North Bute.

The north half of Bute, from the valley of Loch Fad, is composed of Rocks of Clay Schist, Mica Schist, and Greywacke.—Clay Schist simply means Clay Slate, Mica Schist is from the Gr. word Mica (Shining), Chlorite Schist is from the Greek word Chloros (yellowish green), and Greywacke is from the German and signifies Greystone.

In Arran, the granite nucleus is completely encircled by Slate Rocks. On the east side, above Corrie, the slate band is extremely narrow, on the west side it is much broader.

The Slate Rocks are part of a broad zone which traverses Scotland diagonally from sea to sea, intersecting the line of the Clyde shores, and crosses the Islands of Bute and Arran, encircling the granite nucleus already referred to.

According to Professor Geikie these slates belong to the lower Silurian system of rocks. The term Silurian was given

by the illustrious Murchison, because the system of rocks forms large tracts of country in Shropshire and Wales—a region formerly peopled by the Silures, a Celtic race, who fought gloriously against the Romans, under Caractacus or Caradoc, the British king of these tracts.

The next we have to refer to are specimens of the junction of granite and slate from Goatfell. This is a most remarkable formation, as showing the junction of the Igneous and Sedimentary Rocks. The following account, by Prof. Ramsay, of the famous junction at the mill-dam on the ascent to Goatfell (near where the specimens were found) will give an idea of this junction.

The absolute junction of the two rocks is not here visible, but that it is in the immediate neighbourhood, probably in the bed of the dam, is clearly shown by the appearance of a granite vein about one foot broad, which penetrates the strata and crosses the bed of the stream about 10 yards below the artificial wall, which confines the water of the dam. Thus indicating its intrusion, while in a state of fusion, into the stratified deposit with which it came in contact. The granite is of a yellowish colour, fine grained and compact in texture and consists principally of Felspar.

There are several other junctions; the most noteworthy is that of Tor Nead-an-Eoin, about two miles from the village of Lochranza.

We now come to the *old red sandstone*, which is represented by two specimens—the one a sandstone and the other a conglomerate from Achab shore, near Corrie.

The encircling band of slate in Arran referred to, is succeeded on the east and south by a band of old red sandstone, which, like the slate band, is of irregular breadth. It begins to overlie the slate at the Fallen Rocks, north-end of Arran, and occupies the shore, thence half-a-mile north of Corrie. Here it retires inland (the carboniferous taking its place on the shore), crosses in a narrow band to the west

side of Maoldon, and stretches thence westward, around the border of the slate, to the mouth of Machrie water. Between this point and Dougarie, near Iorsa, Waterfoot, it attains its greatest breadth. A line from the north side of Brodick Bay to Dougarie very nearly marks out the line of junction.

The fragments embedded in the conglomerate are Mica, slate from a distant source, the ordinary slate adjoining, and quartz of two varieties not found in Arran, but resembling certain varieties found in Islay and Jura.

The Devonian, or old red sandstone, is so called because the formation is very clearly displayed over a great extent of country in the County of Devon. The name was first proposed by Murchison and Sedgwick in 1837.

The red colour of the old red sandstone of England and Scotland and the total absence of fossils, except in the very uppermost beds, are considered by Professor Ramsay to indicate that the strata were deposited in inland waters.

Mr Etheridge has endeavoured to prove that the Devonian and Old Red Sandstone, though contemporaneous in point of time, were deposited in different areas and under widely different conditions—the one strictly marine, the other altogether fresh water. Vast inland seas or lakes covered with a few islets form the ideal of the Old Red Sandstone period, the vegetation being still simple in its development, and forest trees seem altogether wanting. Cryptogams, of which our mushrooms convey some idea, formed the chief part of this primitive vegetation.

We shall next refer to a remarkable formation to be found in the Old Red Sandstone, viz :— *Barytes*, which is represented by specimens from a vein in Glen Sannox, near the old Barytes Mill. This mill was erected in 1839, and taken down in 1860. The name Barytes comes from the Gr. word Barys, heavy, and is so called from its great density. It is of various colours, but generally of a reddish-white. The veins

of Bartyes referred to are from a few inches to 6 feet thick. They were opened by Mr George Anderson who likewise erected extensive machinery for grinding and purifying the ore. The works were all destroyed many years ago by order of the late Duke of Hamilton's father. The carbonate is employed in the manufacture of plate-glass and in the refining of beet-sugar. The whiter varieties of the sulphate, after being heated and thrown into water, are ground and the heavy white powder used as an adulterant of white lead.

We now come to the *carboniferous system of rocks.*

We may remark that the Carboniferous period succeeds the Devonian or Old Red Sandstone.

The south half of Arran, the southern portion of Bute, from Loch Fad, likewise the Cumbraes, belong to the carboniferous formation. The prevailing rock of the southern half of Arran is red sandstone, varying from a compact structure to that of a coarse conglomerate, broken through and overlaid in a great many parts by Igneous Rocks. A band of this sandstone also extends along the eastern shore, northwards to Corrie, and again from Fallen Rocks to the "Scriden," near the entrance to Lochranza.

The fragments embedded in the conglomerate are the same as those found in the Old Red Sandstone already referred to.

No fragments of granite occur in the Arran sandstones. The conclusion is that when the sandstones and conglomerates were being formed by the wearing down of the slate rocks the granite was still overlaid and protected by its slate covering, and was not exposed to disintegration.

The sandstones of Bute have sometimes been referred to as the "old red sandstone," but Professor Geikie, in his geology of the British Isles, classes it with the lower carboniferous formation. Dr Bryce, in his geology of the Clyde Islands, considers it highly probable that the lowest band traversing

the obscure belt of low land along the border of the slate (bed of Loch Fad) may really yet be found to be of this age (that is belonging to the Old Red Sandstone period).

In further investigation of the subject I have also to remark that, as showing the transition of the slate or grey rocks to that of the sandstone and conglomerate formations, it may be safely said that the valley of Loch Fad contains one of the most interesting geological sections in the Island of Bute.

The most noteworthy portion is on the east bank, a little to the north of Bardarroch Wood, where the partially rounded boulders and fragments of the grey rocks are piled above each other in a very remarkable manner—and strange to say, with their longest axis at nearly the same dip angle as the primitive grey rocks on the west side of the valley—showing very conclusively that the valley must have been filled up with this debris at one time—probably the talus of an ancient glacier.

Another remarkable feature ol the locality is the depth of the Loch. Over 30 years ago I sounded the Loch from end to end and found the deepest part to be nearly opposite the Black Rock—a little to the south of Woodend—where it reaches a depth of 36 feet, or as nearly as possible the present sea level.

The question is—How did the Loch come to be scooped out so much deeper than the present outlet? There can be no doubt that when the sea stood at a higher level the tide and storm must have rushed through this valley like a mighty river, carrying the floating ice-bergs with their load of debris to the outer depths of the ocean.

The next transformation scene was the upheaval of those Igneous Rocks, so well seen between the "Lover's Walk" and Barone Park, and also in those terraced ridges at the south end of the Loch, on the farm of Ambrisbeg, between Loch Fad and Loch Quien—thus barring the outlet of the valley at both ends; and probably along with the upheaval of

these Igneous rocks there was a subsidence along the junction of the slate and sandstone formations, which, I think, is sufficiently attested by the difference in the angle of dip of the respective formations; that of the slate rock dipping to the S.E. at an angle of 50° to 60°, and that of the sandstone to the N.W. at an angle of 30° to 43°. Thus showing that the whole thing has gone down along the line of contact or junction after the sandstone was deposited. Hence, by measuring the angle of depression of the slate and sandstone formations and subtracting the one from the other, we find the angle of repose which the slate rock assumed at the time the sandstone was being deposited.

Another noteworthy feature of the locality is a remarkable *deposit of red clay* on the east bank below Little Grenach.

The late Mr Macintosh, druggist, had several beautiful vases formed of this clay—veritable Terra Cotta.

Referring to the specimens which represent the carboniferous formation, the first is *sandstone from Corrie shore.* It is nearly white in colour and merely local, and the whiteness of the stone is no doubt owing to the absence of colouring matter (peroxide of iron). It has been largely quarried on the shore at one time.

The next is *sandstone from Brodick.* This is apparently identical with the old red sandstone of Achab shore, being red in colour. It has been largely quarried in the neighbourhood of Corrie and Brodick for building purposes. It forms huge cliffs from 100 to 200 feet high on the Corriegills shore, to the east of the new pier.

The Scriden and the Cock of Arran are noteworthy portions of this formation.

The Scriden is a headland whose base is strewed with immense masses of sandstone which fell over a 100 years ago, with a loud noise heard in Bute and Argyll. It was

produced by a landslip, the traces of which yet remain in a long, deep rent near the summit of the cliff.

This part of the carboniferous formation is sometimes referred to as *the Permian period*. The name Permian was proposed by Sir R. Murchison, in the year 1841, for certain deposits which are now known to terminate upwards the great primeval or paleozoic series of rocks. In short, to put it plainly, Permian simply signifies a system of rocks that have been formed out of the ruins of the carboniferous system.

The name Permian is given on account of the deposit being largely developed in Russia, the Government of Perm forming the central part.

The Cock of Arran, already referred to, is a large isolated mass of sandstone on the beach, and is a noted landmark among sailors. When seen from the sea, the block had the form of a cock, with expanded wings, in the act of crowing. The head is now broken off.

Our next specimen is *sandstone from Millport.* This specimen is taken from a quarry about a mile to the west of the town. Several villas on the line of the new road have been built of this stone. It has evidently been much disturbed by the proximity of trap. The white colour is no doubt due to the effects of the trap, the prevailing colour being more or less brown.

Conglomerate sandstone from west shore, Meikle Cumbrae. This is largely made up of glassy quartz pebbles, and is highly ornamental and well suited for forming rock-work. A considerable quantity has been used for that purpose.

Stigmaria.—This is from the sandstone on Corrie shore, already referred to. Several specimens may be seen embedded in the sandstone. Stigmaria were the roots of Sigillaria. The Sigillaria were great trees surmounted with a bunch of slender drooping leaves. It is from the impressions or scars of the old leaves on the stems resembling a seal that it derives its name (Sigillum, a seal). Of course this makes all plain.

Limestone from Corrie Lime Works, which were commenced 100 years ago. Twenty-two beds of limestone are seen interstratified with the same number of beds of red shale.

Hematic iron ore also occurs in the shale in the form of round nodules.

Maoldon—the projecting headland between Corrie and Brodick, is supposed to be an upthrow of the Corrie beds.

Limestone also occurs on the north side of Brodick Church, Saltpans, and Ben-leister Glen.

Producta Shells from Corrie Lime Works.—A remarkable deposit of these shells in the lime-beds here is to be seen in the roof of the old lime working. As indicating the tranquil nature of the deposit, the large producta shells uniformly rest with the convex side of the valve downwards. This is well worthy of a visit.

Limestone Coral.—This deposit is found in certain parts of the Corrie Lime Workings. Coral is a general term for all calcareous marine products secreted by Polypi. It is principally made up of Zoophytes, the remains of which are easily seen. The Polypi referred to secrete the calcareous matter held in solution in the waters of the ocean, and form these wonderful calcareous banks which have been in course of formation during many geological ages.

Limestone from Millport.—Several thin beds are to he seen on the shore to the west of the town.

Limestone from Kilchattan.—This limestone has no fossils, contains much Siliceous matter, and is of little economic value. It is somewhat analogous with the corn-stones of the

Old Red Sandstone. The same vein (at least I consider it so) may be seen on the shore, near to Dunagoil Fort.

I may here remark that this limestone is more of the nature of a hydraulic or water setting limestone, sometimes called bastard limestone.

Limes, when drawn from the kiln and slaked, are usually spoken of as rich or fat, poor or medium, hydraulic and highly hydraulic. Thus, when falling rapidly to quicklime, they are *rich*; when falling only after 8 or 10 minutes, they are *poor*; when they require 15 or 20 minutes, they are *medium*; when requiring an hour or more, they are regarded as hydraulic; and when requiring it may be several days to break up, they are highly or energetically hydraulic. From what I have seen of the Kilchattan limestone it may be regarded as most energetically hydraulic, as some of it (I suppose) will lie for weeks and months together before breaking up.

Limestone from Millhole.—Several courses of nodular limestone traverse beds of brown crumbling shale. Along Ascog shore several thin beds also occur.

Gypsum or Sulphate of Lime.—This was found in making some excavations in the floor of Stewarthall House a number of years ago. After hearing of the discovery I went to make an inspection of the place where it was found, but to my disappointment the soil that had been dug out was all filled in—the work being completed. As far as I could discover it was found deposited on a bed of clay. It is commonly known as Plaster of Paris. When baked in ovens, to discharge its water of crystallisation, it falls into a soft white powder. It is also applied as a manure to grass lands at the rate of two to three cwt. per acre.

It occurs in the new red sandstone of England and Germany, and in the rocks of the neighbourhood of Paris. It consists of one atom of sulphuric acid, one of lime, and two of water. Sp. gr. 2·32.

Hœmatite or Bloodstone.—A kind of iron stone—or native oxide of iron. This somewhat remarkable formation is from the margin of a water run on the west side of Brodick Castle woods—a little to the south of Merkland Burn. It varies from a foot to three feet thick. The specimen is from the centre of the vein, which is a tough compact stone. Immediately alongside the vein there is a soft red shale or clay seven feet thick.

Amongst all the formations, which we have noticed, the one we now come to is perhaps one of the most interesting, viz. : *Coal*—which is represented by specimens from Corrie and Ambrisbeg.

Probably in the Coal period, as at the present time, there existed two distinct kinds of vegetation—one formed of lofty trees growing on the higher grounds, the other herbaceous and aquatic plants growing on marshy plains.

The latter vegetation has mostly furnished the material for coal in the same way that marsh plants have in the present day supplied our existing peat, which may be regarded as a sort of coal in the first stages of its formation.

The humble Equisitæ or mares tail of the present day were represented during the Coal period by herbaceous trees 20 to 30 feet high. Their fossil remains bear the name of Calamites. The Lycopods of our age are humble plants—mostly creepers—but those of the ancient world were trees of 80 or 90 feet in height. Their leaves were sometimes 20 inches long, and their trunks a yard in diameter.

A damp atmosphere with an equable heat, a soft light veiled by permanent fogs were favourable to the growth of this peculiar vegetation. The nearest approach to this geological period is only to be found in certain islands, such as the Island of Chloe, where it rains 300 days in the year, and the light of the sun is shut out by perpetual fogs.

Coal was found a little to the south of the Cock of Arran and an attempt to work it was made about the year 1724 by one, Thomas Semple, who likewise manufactured salt. The principal coal seam is 3 or 4 feet thick. There were workings on two or three seams in the direction of the dip, which is nearly N. at 45°, but all were abandoned when, owing to the depth of the workings, the sea gained access to the pits. It is termed "blind" coal, containing an unusual quantity of carbon, and burns without smoke or flame. Many vegetable impressions, chiefly ferns and calamites, were found in the coal below the shale.

The following account of the various essays to discover coal, and to put it to a practical use, is taken from Blain's MS:—

The coal seam at Ascog was wrought at a very early period, and again in 1663, by Mr Stuart, of Ballintoy, an Irish gentleman of Bute descent, who bored to a considerable depth at high water mark, without making any useful discovery. He, likewise, put down a shank near the centre of the hill. but did not persevere so as to penetrate through the rock.

From a minute of the Town Council of Rothesay, dated 8th October, 1664, it appears that the Council agreed to allow Mr Stuart, of Ascog, to work the coal in the Burgh lands there on condition that he should supply the inhabitants of the town, in preference to all others, with coals.

Some time after, coal was found at Ambrisbeg, but, being thin, the field small and the dip great, the working was neglected. Thereafter, the Earl of Bute had a trial made on his own estate in 1758, and another faint essay was attempted by some of the inhabitants of Rothesay and by a party from Irvine, but all proved unsuccessful.

Again, towards the end of the eighteenth century, the Marquis of Bute made a vigorous effort to find coal, under

the superintendence of skilled persons from Northumberland, who bored in the lands of Barnauld, by the side of Loch Fad, at Kerrycrusach, near the south end of Ascog Loch, in Windyhall ground, on the north-west of the same Loch, and at Dunagoil, without the smallest success. Thereafter no further attempts were made for a long time until, several years ago, a company tried to find coal in the lands of Ambrisbeg, but likewise failed to make it practically useful. Two years ago, Mr M'Lean, Ascog, put down several bores in Ascog Hill, but with no practical result.

In Cumbrae an unsuccessful attempt to find coal was made a long time ago in a field to the west of Millburn House. Whether coal was actually found there or not is uncertain, but upon some of the older maps part of the field is called the "Coalheugh."

Igneous Rocks.—Having referred to the sedimentary rocks, from the granite upwards, we now come to another most interesting class of formations, viz., the Igneous rocks which are represented by specimens from Bute, Arran, Holy Isle, and the Cumbraes.

The Igneous rocks are amongst the most recent formations as they pierce through and overlie the sedimentary rocks from the lowest to the highest. These Igneous rocks are of endless variety, but taken in the broadest acceptation of the term they are all members of the trap family, so well illustrated in the trap or whinstone veins which traverse the county, and which in many cases have given that variety of hill and dale which enters into the composition of the landscape.

The Igneous rocks, as their name implies, have been formed deep down in the crust of the globe, and have belched forth those veins of fire severing the strata, with which they came in contact, as effectively as if done by some gigantic blade of iron.

As this class of rocks are more or less known to the most of you in the form of building stone and road metal, etc., we shall only notice a few of the most noteworthy portions.

With a few exceptions the trap veins (or dikes as they are sometimes called) run within a few degrees of north and south, and may be traced for miles. In other parts they have overlaid the older rocks and form those terraced ridges so well seen at Ascog Hill, the hills south of Kilchattan, Garroch Head, and likewise in the Cumbraes. In ascending the steep part of the road between Largiezean and Lubas the sandstone is to be seen in the face of the cliff, and the trap rocks immediately above it. Not only so, but round the south end of the Island (Garroch Head) the successive layers, or overflowings, are distinctly visible.

The trap rocks in the neighbourhood of Garroch Head are what is called *Felspar Porphyry*. A large quantity of this was quarried and formed into pillars for the entrance hall of old Mountstuart House, previous to its being burned. A considerable portion of this material has again been used in the building of the new house. The material is very refractory and difficult to work, but when polished, looks remarkably well.

Whin Dike, Kerrycroy Wood, on west side of road leading over Ascog Hill. This affords a striking illustration of the mode of cooling of these trap rocks. It forms the perpendicular cliff in front of the sandstone, rising like a wall to the height of thirty or forty feet.

The sandstone has been completely worn away from the seaward face of the veins showing the peculiar formation of the rock to perfection. Part of the vein was quarried some years ago, which somewhat detracts from its original appearance.

The next we shall refer to is a remarkable vein of *Columnar sandstone* on the shore to the south of Kelspoke. This, though not an Igneous formation, shows the effect of

the Igneous on the Sedimentary in a very marked manner. The vein is about 4 or 5 yards wide, and extends from below high water mark up to the cliffs, which lie about 40 yards inland. The best developed tract is near high water mark, and is between 4 and 5 yards square. The columns are all nearly vertical, none being more than 20 degrees from the perpendicular.

They vary in size from 6 inches down to ½-inch in diameter, and the number of sides vary from four to eight and ten. Six being the most common. Steam or highly heated vapour is supposed to have been the cause of the Columnar structure.

Columnar coal is sometimes found in both Lanarkshire and Ayrshire. It has also been observed that the sandstone pavement of blast-furnaces, which have been long in use, is often rendered Columnar; the columns, like those in the sandstone at Kelspoke, being vertical to the bedding of the stone.

Perched Boulder.—Before leaving the locality I have also to refer to what is termed a perched boulder, or mushroom stone, which stood on the Kelspoke shore, south of Kilchattan, over 30 years ago, and which was figured and described by Mr D. Corse Glen, C.E., in the Glasgow Geological Society's Transactions, of 13th December, 1873. The following is Mr Glen's description of the boulder:—"The upper part or table is a Micaceous Schist, and the pedestal or pillar is a bedded sandstone which is so very soft that it can be rubbed away with the fingers. The table has at one time been larger, a considerable corner having split off and is now lying at its base. The present dimensions of the table are twelve feet long, seven feet broad, and five feet thick. The pillar is two feet in diameter, and the top of the table is eight feet above the level of the shore at this place."

This remarkable stone has long since disappeared—wind, weather, and tide having sapped the foundations of what was a noteworthy landmark of the locality.

According to historic lore, there were several of these perched boulders at one time on the Kelspoke shore, which the grandfather of the present Lord Bute styled "Kilmarnock Caps."

Returning to the Igneous Rocks.—In Meikle Cumbrae there are also some remarkable trap veins. The best example is seen a little to the east of Millport, where a dike rises from the sea like a huge wall and runs up the hillside as if it were raised by art. A noted portion of this rock on the sea-shore is called the "Lion Rock." A continuation of the dike is seen on the shore on the mainland, and is referred to in the legend that this strait was once spanned by an enormous bridge raised by the hands of mighty wizards. The only portions that remain are these two ancient abutments on the shore, referred to.

In Arran, the trap veins or dikes are more finely developed than in Bute. There are hundreds of dikes to be seen, from a few inches to several yards in thickness.

A very noteworthy feature of some of the trap rocks in Bute is that they are largely composed of iron which is highly magnetic. The east and south shores of the Island are largely bestrewn with *iron sand*, which has been formed or pounded down by the abrading action of the sea and weather on the trap rocks in the neighbourhood.

At Garroch Head this sand is likewise abundant, the black particles being almost invariably composed of iron, which can be easily gathered with a magnet.

We now come to another important feature in connection with the trappean rocks. During the autumn of 1865, Mr Edward A. Wunsch, of Glasgow, discovered trappean ash beds in the north end of Arran, which contained stems of trees. The beds are shown in section in the position and in the terraced form into which they have been worn by the action of the sea. Twelve or fourteen trunks in all have been observed with their roots descending into the shale and

branches lying about in the beds fully mineralised, yet having their structure beautifully preserved, indicating that the plants grew in a marshy situation, and that the ash from the volcanic vent (which must have been in the neighbourhood) quietly and gradually enveloped the stems.

Claystone from Holy Isle.—It may be here remarked that the Island is principally composed of this rock which varies in structure from a soft claystone to a compact felspar. The harder varieties are called clink-stone.

Pitchstone from Brodick and Moneadh Mhor Glen.—This is another remarkable formation, and at first sight resembles bottle glass. There are two varieties. That from Moneadh Mhor Glen is called Pitchstone Porphyry.

Claystone Porphyry from Kilpatric Hills, on the west side of Arran.—The hills are strewn with large blocks for several miles. At a distance a stranger would think it was a vast herd of cattle. Owing to the surface of the rock decomposing into a dark brown, the hills have received the name of the "Brown Hills."

In the early days of railway construction, great quantities of this rock were quarried on the shore and transported to the mainland, being used instead of wooden sleepers.

Hundreds of these blocks are lying about, all bored and ready, as the quarrymen left them.