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## Chapter 5 The Old Red Sandstone

As a whole the Old Red Sandstone occupies a semicircular strip of country stretching from the Fallen Rocks 2 miles north-northwest of Sannox Bay to the west coast of the island. It passes between Corrie and the eastern margin of the northern granite, through Glen Rosa, and then turns westward following the southern margin of the ring of Dalradian schists, thus reaching the western coast south of Dougrie. The average width of this annular strip is about 1 mile (see One-inch Geological Map of Arran). The outcrop has a large bulbous extension to 3 miles south of the String Road, but the greater part of this mass has been obliterated by, or rather, incorporated into, the Central Ring structure.

The formation consists of two divisions, Lower and Upper, conforming to the general classification of the Old Red Sandstone in the Caledonian basin of deposition. There must be an extensive stratigraphical gap between the two formations, but there is singularly little direct evidence for unconformity. This may be partly because of the prevalent high dips, and partly because there is no abrupt change in the characters of the sediments. Gunn has written (MS. notes) that the rocks of the lower division are more felspathic than those of the upper, and their colour is not so bright a red. When the rocks are altered by contact with intrusive igneous rocks, as they so often are, the beds of the lower division become hard and grey in colour, while those of the upper division, which are more quartzose, turn white; and this difference assists materially in drawing a boundary line which is often otherwise obscure or conventional.

The boundary between the Lower Old Red Sandstone and the underlying schists is everywhere faulted; and even where the formation comes into contact with the northern granite, as it does near Corrie, Mr. E. B. Bailey has shown that the boundary is faulted to such an extent that a band of mylonite has been formed, <ref>E. B. Bailey, *Geol. Mag.*, vol. lxiii., 1926, p. 486.</ref> as, for example, in the White Water junction. Around the Central Ring structure the Old Red Sandstone has a normal intrusive contact, very much shattered and interpenetrated, with the Cainozoic gabbro, granite, and felsite. In general the Upper Old Red Sandstone passes with perfect conformity of strike and dip into the basal beds of the Carboniferous.

### The Lower Old Red Sandstone

The greater part of the area outlined above is occupied by the lower division of the Old Red Sandstone, which always appears on the concave northern side of the semicircular outcrop, next to the schists and granite. The formation is well exposed in North and South Glen Sannox, in Glen Rosa, and in the burns immediately to the north of the String Road. There is also a good section towards the head of the Clauchan Glen on the south side of the Central Ring area.

The sediments seen in North and South Glen Sannox consist of coarse conglomerates, red mudstones, and purplish or chocolate-coloured felspathic sandstones, and they may serve for a general description of the lithological types occurring in the formation as a whole. The blocks in the conglomerates are well rounded, and many of them are of a pinkish or white quartzite, often associated with pebbles of andesite derived from the denudation of lavas belonging to a lower part of the formation. The conglomerates are associated with, and alternate with, beds of red or purplish fine sandstone and mudstone; they generally form the lowest and most westerly part of the formation as exposed in these glens. The middle portion is composed largely of mudstones and flaggy sandstones, and the higher part is mainly felspathic sandstone, somewhat coarser and thicker-bedded than that in the middle part.

Around the Central Ring area, especially in the Clauchan Glen, and at the head of Glen Dubh, the Lower Old Red Sandstone has been greatly altered by the heat, and also by emanations, from the adjacent igneous centre, so that now they are totally unlike Old Red Sandstones in character. They are, in fact, more like old Silurian greywackes, very hard and tough, and of a bluish-grey colour. They are also apparently contorted in places, and the bedding cannot always be determined.

Where the outcrops are small, and broken up by faulting or igneous intrusion, these altered rocks often cannot be traced into the normal reddish and purplish sediments; and as there are at least three series of sandstones and shales outcropping in the vicinity of the eastern edge of the central igneous area, it is often a matter of perplexity to assign the

altered rocks to their correct formation. This is particularly the case at the heads of Glen Dubh and Glen Ormidale.

A related type of alteration, although not by direct contact with igneous magma, is to be found in the Lower Old Red Sandstone near the head of the Merkland Burn, north of Brodick, at least half a mile distant from the margin of the northern granite. These rocks are indurated and epidotized, and seem to represent an area through which emanations streamed from the neighbouring granite. This region is more fully dealt with below (p. 35).

High easterly or south-easterly dips are prevalent in the Lower Old Red Sandstone over the eastern and southern part of its outcrop. Dips to the S.S.W. and S.W., however, prevail in the extreme west near Auchencar. The easterly dips are mainly to be found in the outcrop near Sannox on the east coast. Hence there is some evidence of a radial disposition of the dips outwards from the northern granite mass, as if a dome-shaped elevation had been caused by the intrusion of the granite. G.W.T.

## Stratigraphical details

A great series of purplish-red and chocolate-coloured sandstones, generally hard and micaceous, and often thin-bedded, occupies Glen Shurig and strikes south-west, with a high dip to the south-east, across the String Road. These rocks have been quarried in places for road metal. They form, apparently, the highest portion of the lower division of the formation. As the dip is high, they must be between 2000 and 3000 feet in thickness. Although in places the dip is reversed there are no apparent contortions, so that the strata are probably occasionally inverted, as they must be in the Cnocan Burn and on the west side of Glen Rosa. It was in this group of rocks in Glen Shurig, in a burn near the String Road, that Sir A. Geikie and his students found a specimen of *Psilophyton* in the year 1882. From the same upper part of this subdivision in Glen Shurig about a dozen specimens of plants were obtained by Messrs. Macconochie and Tait, the fossil collectors of the Geological Survey, in 1897. Dr. Kidston, to whom these were submitted for examination, could only identify one of them specifically as *Psilophyton princeps*, var. *ornatus* Dawson. He thought, however, that all the other specimens belonged to this species, which is characteristic of the Perthshire and Forfarshire Old Red Sandstone, and is not known in the Caithness Flags. The strata in which these plants were found are hard, purplish, flaggy, micaceous sandstones, often weathering to a yellow tint, and they must be several hundred feet lower in the formation than those which yielded *Psilophyton* in 1882, but both belong to the same set of beds. The exact locality for the specimens collected by the Geological Survey in 1897 is in the main stream of Glen Shurig, about 200 yards above its junction with Allt Mòr, which is its principal tributary on the south side. In the south bank of the stream at this point is a good shale band about 3 inches thick, and it was from this bed that the "plants were obtained. Some fragments were also got on a somewhat higher horizon, some 100 yards lower down the burn and nearer Allt Mòr, and it was in Allt Mòr itself, but some distance up from its foot, that the specimen was obtained in 1882.

The thick masses of mudstone, interstratified with coarse conglomerates made up mainly of quartzite pebbles, so conspicuous in North and South Glen Sannox, are much attenuated in Glen Shurig, while the upper felspathic sandstones are much thicker. W.G.

A good section in the Lower Old Red Sandstone is exposed in the Allt an Bhrighide, a northern tributary of Glen Shurig. Vertical chocolate and red fine-grained sandstones are seen to the north of West Glenshurig. Higher up, near 674 feet O.D., and just at the corner of the wood, there are fine exposures of coarse andesitic breccias, and associated dark sandstones which look like tuffs, but are probably due to the denudation of an andesite lava area of earlier date. Above these igneous breccias comes a great thickness of typical torrential quartz- and quartzite-conglomerate, interbedded with fine-grained chocolate-coloured sandstones, and coarse, gritty, pink sandstones. The strike ranges from north-west to north, and the rocks in general have a vertical attitude.

In Glen Rosa, near the schists, at the sharp bend in the burn below Coire Fhraoich, a type of Old Red Sandstone is seen which approximates in character to the 'doubtful rocks' of the Merkland Burn, and the contact-metamorphosed types. Its colours are grey and green, not red and purplish. The rocks consist of coarse grits and fine conglomerates rich in small quartz pebbles, subordinate sandstones, and thin bands of slaty mudstone. All the rocks are altered and indurated, and the grits are epidotized. The strike is N.N.E. and the dip between 70° and 80° to the W.N.W. Where the Glen Rosa path crosses a tributary which joins the burn practically at the above-mentioned angle, there is a visible junction between the

Old Red Sandstone and the schistose grits and slates. As the schists strike N.E. there is a discordance of strike of about 30° between the two formations. According to Gunn<ref>Geology of North Arran, etc., (Explanation of Sheet 21), *Mem. Geol. Surv.*, 1903, p. 24.</ref> similar rocks occur near the schists in Garbh Allt, north of Monyquill. Apparently most of the exposures of Old Red Sandstone near the granite margin will be found to be affected in some degree by the igneous emanations. G.W.T.

East of Dougrie there are fine sections in the Old Red Sandstone on the shore and in the old sea-cliffs, but a portion of the rocks there exposed probably belongs to the upper division of the formation. The Lower Old Red Division, which is characterized by thick bands of coarse quartzite-conglomerate, alternating with red and purplish sandstones, must in places on this side of the island have a thickness of several thousand feet, with a high southerly dip ranging from S.S.W. to S.S.E. The coarse conglomerate forms a broken ridge of high ground east of Auchencar, and is apparently unusually thick in the hill of Garbh Thorr, near Monyquill, which is probably bounded on either side by a large fault. Below this mass of conglomerate is found a volcanic zone, composed of lavas some 50 or 60 feet thick, which is elsewhere described (p. 36). These crop out in Auchencar Burn, to the north of the hill Baniorlach, 1¼ miles farther east, and to the north-west of Garbh Thorr. Below this zone the rocks consist mainly of sandstone. The sandstones which overlie the conglomerate, mostly thin-bedded or flaggy, are exposed in the Machrie Burn, west of Cnoc na Ceille.

The boundary between these undoubted Lower Old Red Sandstones and the beds above which may belong to the upper division of the formation, is somewhat arbitrary and uncertain, as the dip and strike of the two set of rocks are, on this side of the island, everywhere the same, and no fossils can be obtained to assist us in the determination of the exact line. In the old sea-cliff, near the Dougrie schoolhouse, more than half a mile north of Auchagallon, there is a variegated marl bed covered with oval or round white and greenish spots, and there are also narrow bands of the same material along joints, some of which are also lines of movement. This bed, which is 12 to 15 feet in thickness, with some irregular sandstone on one side, contains doubtful traces of plants. This band is included in the lower division, and the rocks above are referred doubtfully to the upper or middle division. Similar greenish marl bands are found along the strike in the Machrie Burn, and in a smaller burn farther east, and some much thinner bands of the same kind also occur in the Machrie Water, so that the line given on the map seems to follow a definite horizon, if it is not an actual boundary between two sub-formations. Below these bands in the Machrie Water the rock is much hardened and jointed, for which alteration there is no visible cause except an intrusive basic dyke. W.G.

The Lower Old Red Sandstone occupies a considerable area in the region about the head of the Clauchan Glen and Cnoc na Croise (1346 feet), to the south of the Central Ring structure. The exposures are not very good, and occur principally in the Clauchan Burn, and in the lower part of a small tributary which enters the main stream north-west of Cnoc a' Chapuill. In the latter stream the rocks are much baked, and the bedding is obscure and in some places apparently destroyed. Near the foot of the burn, bluish and purplish mudstone dips to the south at 45°, but higher up come bluish-grey rocks with no appearance of bedding. They seem to be altered grits and mudstones, shattered in places; and are cut by occasional basic dykes. Near the base of the upper division appears a mass of conglomerate with a high dip to the south. The rocks crop out in places to the east of this burn, but the ground is generally obscure. Beds of grey grit and dark-grey mudstone, thin grey grit, and greyish pebbly felspathic sandstone with a dip east of south, between 30° and 60°, are seen only occasionally. About 200 yards west of the foot of the small burn, a section appears in the south bank of the main stream. The rock is a blocky grey felspathic pebbly grit which just appears under a thick mass of boulder-clay. A grey or purplish grit of a somewhat similar character crops out about 100 yards farther west, and dips S.S.W. at an angle of 25°, while 200 yards farther down, and still on the south side of the stream, are reddish, purple, and grey hard felspathic sandstones, dipping S.S.W. at 20°. Somewhat farther west the sandstone is brecciated, with clayey galls in places; and at this place is drawn the line between the two divisions of the formation. W.G. (MS.)

### **Altered rocks**

In the upper part of the Merkland Burn, outside the Castle woods at Brodick, there are some rocks of a peculiar type in this division. Near the edge of the wood, but inside, conglomerates with well-rounded pebbles of the true Lower Old Red type may be observed in a vertical position and with a northerly strike. Succeeding to these, outside the wood we find sandy red mudstones in the stream for 100 yards. They have the same vertical attitude as the conglomerates, but the last visible strata of this kind have a strike directed somewhat west of north. These rocks are abruptly truncated at a waterfall

by a totally different set which come on along a line running about north-north-east. The junction line may be a fault, and the rock which we first come to on the other side has somewhat the appearance of a dyke a few feet in width. North of this we seem to have recognizable purplish mudstones, altered, however, with another possible green dyke parallel to the stream on the west side. Below the first branch stream on the west side there appear to be fairly recognizable altered mudstones striking north-east and dipping south-west. All these rocks have a number of yellowish-green veins and patches of epidote.

For a long way above this, in the main stream, is a mass of apparently fine-grained blue-grey rock with very indistinct traces of bedding, and not at all resembling the ordinary type of Old Red Sandstone. Similar rocks may be seen in both the branch streams on the west for a distance of about 200 yards up them, where rocks of an undoubted gritty character appear. In the upper branch stream this is a white hard-baked sandstone, almost a quartzite, which has evidently undergone considerable alteration. This has been microscopically examined by Mr. Kynaston, and is seen to consist principally of numerous small rounded grains of quartz and felspar, some of which is microcline and some plagioclase. The interstitial material often has the appearance of a fine quartzose mosaic, as if it had been recrystallized, but the larger grains show no perceptible alteration. There are some grains of epidote. The highest observed rock in the main stream, 700 yards above the wood, is clearly an altered sedimentary rock, a rather coarse grit with numerous fragments of andesite, more or less rolled, quartz-grains, felspar, epidote, etc.

Some specimens from this locality, however, are very like felsitic tuffs or agglomerate, and some of the fragments have points of resemblance to the salite-dabase of Glen Rosa. But it must be remembered that in places the undoubted Lower Old Red conglomerates are largely made up of fragments of old basic lavas. Mr. Kynaston, however, examined and reported on some thin sections cut from the rocks as well as some undoubted Old Red rocks from the immediate neighbourhood, and inclined to the view that they are of pyroclastic origin, of the nature of tuffs or agglomerates. [Geology of North Arran, etc., \(Explanation of Sheet 21\), Mem. Geol. Surv., 1903, p. 173.](#) One of the specimens sliced was the supposed dyke at the edge of the mass, which is a fine-grained dark rock, apparently of a massive character. Under the microscope, however, it appears partly andesitic, and in a more or less fragmentary condition, and partly consists of small fragments of quartz and patches of calcite in a fine matrix. It is difficult to determine the exact nature of this rock, and it seems possible that it is essentially a massive rock which has been broken or crushed along or near a line of fault, which may be of later date than the alteration surrounding the doubtful rock, for there is no trace of such alteration on this side in the Lower Old Red mudstones.

These doubtful rocks cannot be observed in the drift-covered and peaty ground east of the main stream, but they would appear to be comprised in an oval area which is about 500 yards in length from north to south. As the rocks of this area differ so much in character from the genuine Lower Old Red Sandstone of the neighbourhood, and as they have many points of resemblance to tuffs or agglomerates of pyroclastic origin, it seems more probable that they belong to the latter class. It will be most convenient, then, to consider this small area as the site of a volcanic vent in the Lower Old Red Sandstone rocks, the age of the vent or the period when there was outpouring of either lavas or tuffs being still to be determined.

There remains to be considered the undoubted alteration in the surrounding rocks; at all events on the western border of the area. The large mass of granite suggests itself as the cause of the alteration; but the edge of the granite is half a mile distant, and metamorphism in the surrounding rocks cannot be traced so far away from its mass. Often in the case of the Old Red Sandstone it only extends some 40 or 50 yards away from the boundary. On the contrary, the evidence, so far as it goes, favours the view that the alteration in the surrounding rocks came from within the doubtful area itself, and it seems extremely probable that the operating causes were gaseous exhalations and emissions of heated aqueous vapour in connection with a solfatara. W.G.

The type of alteration described above seems to have been of the same nature as that which is to be observed in the Old Red Sandstone at numerous places around the northern granite and the Central Ring Complex. At the head of the Merkland Burn, however, the alteration seems to have affected sandstones and conglomerates made up, as the Old Red Sandstone is elsewhere, of andesitic and other lava detritus. Hence the resemblance to tuffs and agglomerates which Mr. Kynaston noticed in the appended petrographical descriptions: [Geology of North Arran, etc., \(Explanation of Sheet 21\), Mem. Geol. Surv., 1903, p. 173.](#)

'(S7541) [NS 011 399]. Merkland Burn, west branch, 500 feet above junction. A dark greenish rock, in which numerous small irregular fragments are easily seen with the naked eye. The microscope shows numerous small fragments of andesite and felsite (?) up to about an eighth of an inch in diameter, broken plagioclases, and quartz grains, grains of epidote, chlorite, etc., in a fine matrix consisting apparently of smaller fragments of a similar nature, though much obscured by greenish alteration products and iron-ores. The quartz and epidote often tend to form in patches and irregular veins.'

'(S7542) [NS 010 390]. Merkland Burn. Similar to the preceding, but consisting of larger fragments, which are mainly andesitic, and showing very little matrix. These rocks do not resemble the matrix of the conglomerate as seen in 9393B; but suggest rather rocks of pyroclastic origin, such as tuffs or agglomerates.'

While these rocks certainly do not resemble the conglomerate from the Sannox Burn (S9393B) [NS 000 450], they are closely similar to a normal andesitic conglomerate or breccia from the Allt an Bhrighide, Glen Shurig (S24369) [NR 990 370], a locality about 2 miles distant from the Merkland Burn.

Epidotization and silicification seem to have been the main processes of alteration concerned. A comparison with the alteration effected by 'pneumatolysis' around the ring structures of south-eastern Mull, which has chiefly affected Tertiary igneous rocks, especially the basaltic lavas, may be instituted. In the latter, strings, veins, and amygdales containing epidote and albite, have been developed, and olivine has been destroyed.<ref>Tertiary and Post-Tertiary Geology of Mull, Loch Aline, and Oban, *Mem. Geol. Surv.*, 1924, p. 94</ref> In Arran the alteration has chiefly affected arenaceous rocks, in which epidote and quartz, but not albite so far as known, have been developed. The original red and purplish tints of the rocks have been changed to greyish and greenish colours; and at the same time the rocks have been greatly indurated, and their structural features partially obliterated, as has also been the case in Mull. The cause of this alteration was undoubtedly gaseous and liquid emanations from the neighbouring igneous centres, as Mr. Gunn, with his usual acuteness, had suggested (p. 35). At the head of the Merkland Burn, where the altered area is a mile from the granite margin, it may be surmised that a projecting tongue of granite occurs at no great distance beneath the surface. G.W.T.

### **Contemporaneous igneous rocks of Lower Old Red Sandstone age**

In the Lower Old Red Series of Arran, on the west side of the island, is an interbedded volcanic series. It occurs near Auchencar as a band of lava, and may be traced eastward for about 2.5 miles as far as to the north-west side of Garbh Thorr, near Monyquil. Everywhere it dips steeply to the south and underlies the main mass of the conglomerates, while the strata below it consist principally of sandstones. Where this lava crops out at the surface it is largely amygdaloidal and apparently of a basic character, though the lower portion of it is in places more compact, and seems to be more basic than the rest. The best section of it occurs in the Auchencar Burn, about 70 yards east of the moor fence, where a thickness of from 50 to 60 feet is exposed. Here the rock is amygdaloidal above and compact below. As the band is nearly vertical it occupies but a narrow strip of ground, and, besides, it is a good deal concealed by drift. Still, traces of it may be found in several places to the eastward, and undoubted outcrops of it occur to the north of a conglomerate hill called Bainorlach, and also to the north-west of Garbh Thorr, where the band appears to be thicker than in the Auchencar Burn.

In the conglomerates above this volcanic zone, pebbles of an andesitic rock, presumably derived from the lava, are common. It seems probable that the volcanic series was largely denuded before and during the formation of these conglomerates, which contain these basic igneous pebbles in various parts of the island where no other traces of the former presence of these contemporaneous rocks exist. W.G.

The available slices exhibit two types of rock in this volcanic zone: olivine-andesites of basaltoid habit, and hornblende-andesites of trachytoid habit, of which the latter appears to be the more abundant. In his description Mr. Kynaston<ref>Geology of North Arran, etc., *Mem. Geol. Surv.*, 1903, pp. 171–173.</ref> doubtfully referred some of these rocks to olivine-basalt and basalt, but the minerals he described as pseudomorphic after olivine may in some cases be resorbed hornblendes. Pebbles from the conglomerates that overlie the lavas, and from other horizons, most often consist of hornblendeandesite.

A slice of a lava from the Auchencar Burn ([S9388](#)) [NR 89 36] shows numerous pseudomorphs in colourless serpentine after olivine, and a few highly-calcified microphenocrysts probably of a pyroxene, in a groundmass consisting mainly of plagioclase felspar (andesine and oligoclase-andesine), with magnetite and small flakes of biotite. This rock is on the borderline between andesite and basalt, and resembles the olivine-andesites that have been described from Lower Old Red Sandstone volcanic horizons elsewhere in Scotland.<ref>G. W. Tyrrell, A Petrographical Sketch of the Carrick Hills, *Trans. Geol. Soc. Glasgow*, vol. xv., part i., 1914, pp. 64–83.</ref> Other two rocks of approximately the same characters occur N.W. of Garbh Thorr, near Monyquill, in the same area ([S9389](#)) [NR 92 36]–([S9390](#)) [NR 92 36]. The olivine (?) pseudomorphs are black with separated magnetite, and pyroxene microphenocrysts are definitely recognizable as such.

The hornblende-andesites occur as pebbles in the Lower Old Red Sandstone conglomerates. Mr. Kynaston has described a typical example as follows:

'([S9391](#)) [NR 89 36]. Scar, east of Creag Mhòr, Auchencar. Pebble in Lower Old Red conglomerate. A reddish purple lava with irregular amygdaloids of calcite, and showing small porphyritic felspars. This is evidently a more acid type of rock than any of the preceding. The microscope shows numerous idiomorphic crystals and crystal-groups of brownish hornblende, for the most part now almost entirely replaced by pseudomorphs of iron-oxide. Sometimes the inner portion of the crystal retains some of the original brown colour, but there is invariably a deep opaque border of iron-oxide. Pleochroism is scarcely noticeable. The characteristic cleavages of the original hornblende may be seen in one or two cases. The felspar phenocrysts are fairly numerous. They are evidently mainly plagioclase, probably an acid variety, though some individuals only show the Carlsbad twinning. Apatite is accessory, and of a brownish tint. The matrix consists mainly of small felspar microlites (trachytic type), though a good deal obscured by small flecks of iron-ore. *Hornblende-Andesite.*'

Other very similar rocks occur as pebbles in the Lower Old Red Sandstone conglomerates of the Sannox Burn ([S9392](#)) [NS 000 450], ([S9393A](#)) [NS 000 450] and ([S9393B](#)) [NS 000 450]. A recently collected specimen of the Lower Old Red Sandstone conglomerate from the Allt an Bhrighide, Glen Shurig, Brodick ([S24309](#)) [NS 402 207] shows numerous large pebbles of hornblende-andesite similar to that described above, but with beautifully developed trachytic texture in the groundmass, in a matrix consisting almost entirely of small chips, crystals, and comminuted debris from the same rock.

### **Intrusive igneous rocks of (?) Lower Old Red Sandstone Age**

In Glen Rosa, about three-quarters of a mile west of the hamlet, is an intrusive sill in the Lower Old Red Sandstone. It crops out in the southern bank of the stream, and may be traced up the hillside to the southward and over the moor for nearly a mile. Two prominent knolls formed by it are called Torr Breac and Torr Dubh, and at these places the sill is about 300 feet in width. The rock is very massive, fine grained, grey or pinkish in colour, and contains in places veins of epidote. It is a peculiar rock, and seems of an intermediate rather than basic composition. It appears always to contain a pale-coloured augite, and is a salite-diorite. Three slices of this intrusion are contained in the Survey collection ([S7444](#)) [NR 999 376], ([S7519](#)) [NR 999 376], ([S7520](#)) [NR 98 38]. Mr. Kynaston<ref>Geology of North Arran, etc., *Mem. Geol. Surv.*, 1903, p. 173.</ref> described the rock as consisting: 'essentially of more or less lath-shaped felspars, grains and aggregates of pale augite, patches of chlorite, and some secondary quartz. Apatite and iron-ores are accessory. Grains of epidote are sometimes seen, and the rock is occasionally traversed by narrow veins of epidote and calcite.'

### **Upper Old Red Sandstone**

The rocks of this division of the Old Red Sandstone have been much studied in the island of Arran, where they occupy the shore from the old March of Achag (not Achab) Farm, north of Corrie, to the Fallen Rocks at Corloch, a distance of 3 miles. They were supposed to be typical of the whole formation of the island, but, as will be seen from the sequel, they represent only the upper part of the formation, while the Lower Old Red division is only seen in the interior on this side of the island. The equivalents of these beds in Great Cumbrae and in Bute were, while the survey of those islands was in progress, classed with the Lower Carboniferous rocks, with which they are in general perfectly conformable in the matter of dip and strike. In all three localities there are alternations of red sandstones, often false-bedded, with brecciated conglomerates, made up largely of fragments of quartz and schist derived from the denudation of the metamorphic rocks.

Mingled with these, which are often more or less angular, are well-rounded pebbles or blocks of quartzite derived from the conglomerates of the Lower Old Red division. Bands of shale, when they occur, are thin, and they form but an insignificant portion of the whole. As may be gathered from the name of the division the rocks are generally of a red colour.

No organic remains have been found in these rocks, save doubtful fragments of plants on the shore about a quarter of a mile south of Farchan Mòr.

On the north side of North Glen Sannox there are two distinct sets of beds, separated by a contemporaneous volcanic series, which probably belong to the upper division of the Old Red formation.

Above the shepherd's house we find, along the hillside, a purplish-red felspathic sandstone which is pebbly in places. The pebbles are generally small, and are of coarse, reddish quartzite and white quartz, which are mingled together. Some thin bands of purplish and red mudstone, like the thick masses which occur lower down in the formation, are occasionally seen. The pebbles which occur in the sandstone are well rounded, especially those of quartzite. The dip of these rocks is clearly to the east-north-east, at angles of from 20° to 30°. These beds undoubtedly are the upper portion of the Lower Old Red Sandstone.

At the top of the slope where these beds are found a line of crags may be observed which consist of a very different type of rock, a whitish conglomerate in a nearly horizontal position, and with every appearance of being unconformable to the beds first described. The pebbles in this conglomerate are mainly of white quartz not well rounded, though a few of the well-rounded quartzite pebbles common in the lower division also occur. The numerous quartz pebbles give the rock a decidedly grey colour when seen from a distance, though the matrix is often somewhat tinged with red. Farther west, beyond the first large fault, there are many rounded quartz pebbles and some of schist in the basement beds. The rocks in these crags must be considered as the lowest portion of the Upper Old Red division. They have a gentle dip to the northward and pass under a succession of massive, whitish conglomerates of like character, which alternate with reddish, flaggy sandstones. The whole forms a fine set of parallel escarpments much broken by faults. The dip gradually increases till it reaches 25° or 30° in the highest beds of the series, a set of whitish and somewhat flaggy sandstones which are occasionally pebbly and which underlie the contemporaneous igneous rocks. The beds as above described have a probable thickness of about 800 feet below the lavas. The latter are purplish-red rocks, often amygdaloidal and decomposed, which are elsewhere described (*see p. 42*). They are much faulted; their thickness is probably not more than 100 feet at the most, and they appear to thin away rapidly to the southward. Above them comes a series of red, flaggy sandstones which are surmounted by the ordinary red conglomerates and sandstones partly exposed along the adjacent coast, the highest bed of which has furnished the material for the Fallen Rocks. To the south-east of the Rocks it is principally conglomerate we find on the shore for a distance of half a mile, when, after passing a fault ranging north-east, we come upon the flaggy sandstones which overlie the volcanic series. These occupy the shore for some 600 yards farther. They dip N.E. and N.N.E. at comparatively low angles, 15° on average, and at the south end are faulted against a coarse conglomerate, which occupies the shore for 200 yards, and is then cut off by a fault ranging E.N.E., which brings up much lower beds. From this point, which is 700 yards from North Sannox Burn, the section is very complicated and could not be described accurately without much detail. There are numerous faults and in one place irregular bands of impure cornstone, perhaps on the same horizon as one seen at Farchan Mòr. There is no trace of the volcanic series, and nearer to North Sannox there is strong evidence for an unconformity, where in more than one place dull red sandstone abuts in a peculiar way against conglomerate. Perhaps this may be the reason for the absence of the lavas. As we approach the burn the dip tends more and more towards the east, and on the south of the stream it becomes south of east, and we have passed over the anticlinal line so called. The sandstones and conglomerates that lie immediately south of the burn dip about E.S.E. at angles of 30° to 40°. They strongly resemble the beds which are known to occur below the lavas, and it is very probable they are a part of that series. Above them there appears to be an unconformity- of the same kind as that occurring north of the burn. The rocks which succeed are a series of flaggy red sandstone with occasional pebbly bands, and these continue to the cross-wall, where comes on the thick conglomerate which extends a long way on the shore and which forms the fine crag called the Blue Rock. At the south end of the shore-section, nearly a quarter of a mile from the South Sannox Burn, is an interesting section. A sharp line on the foreshore running N.N.W., which appears to be a joint and not a fault, divides sandstone from conglomerate for the greater part of its length, but near low-water mark sandstone is found on both sides of this line, beyond the point where

the conglomerate is seen to overlap beds of sandstone. Near high-water mark, also, conglomerate occurs east of the line, wrapping round beds of sandstone. It is clear in this case there is a local unconformity. Somewhat similar cases occur south of Farchan Mòr, one of which is near the Rocking Stone. The coarse conglomerate bed on which stands this stone overlaps beds of soft, shaly, red sandstone which lie below. A large fault which runs nearly parallel to the coast truncates this conglomerate near high-water mark, perhaps a continuation of the fault which passes on the west of the Blue Rock; and some distance southward there are several smaller faults. Near these some curious hardened markings project from the surface of the sandstone; some appear vertical like finger ends, and others resemble worm castings which are arranged into various patterns. The rocks to the southward are mostly red sandstones, sometimes false-bedded, which dip south-east at angles from 20° to 30°. There are some beds of conglomerate, one of which forms the highest part of the formation, about a quarter of a mile north of the Corrie Schoolhouse. These higher beds are shown in the section of the Carboniferous rocks ((Figure 1), p. 45).

To the west of Corrie the ground occupied by the Old Red Sandstone is much faulted, and also obscured by glacial deposits, and the division between the upper and the lower parts of the formation is very uncertain. Most of the writers on Arran describe a narrow band of schist or slate along the eastern border of the granite for a distance of about 3 miles southward from Glen Sannox, but Old Red Sandstone certainly is the rock which occupies this position excepting for a length of half a mile to the east of Cioch na h-Oighe, where a band of altered schist occurs next to the granite. It is mainly the lower division of the Old Red Sandstone that is in contact with the granite along this line, and it is doubtful if the upper division and the granite ever come together. The width, however, occupied by the whole formation as it is exposed at the surface is narrowed to 500 yards at the Locherim Burn, and is not more than 400 yards south of the White Water.

The lower boundary of the upper division to the south of Corrie is but an arbitrary line, as the dip and strike of both divisions are the same. It has been drawn, however, through the Brodick woods and up Glen Shurig, so as to include in the upper division rocks which could not be referred to the lower division. South of Glen (Gleann) Dubh, where nearly all the Old Red rocks are much altered, the more felspathic rocks of the Lower Old Red become grey in colour, while the more quartzose rocks of the upper division are turned white, and this difference in colour assists one considerably in deciding on the boundary between them. Some of the rocks of the Upper Old Red are converted into quartzite.

In the Clauchan Glen, to the south-west of Beinn Bhreac, there is a thick series of white sandstones and conglomerates which apparently occupy the position of the Upper Old Red rocks, though they do not much resemble them in character, and certainly not in colour. The white colour may be due, however, to the same cause which has so highly affected the Lower Old Red Sandstone of this district, viz., the intrusion of the granophyre and other rocks of Beinn Bhreac.

On the western side of the island the beds above the genuine Lower Old Red Sandstone are very variable. On the shore and in the old sea-cliffs north of Auchagallon they are mainly conglomerates with some pebbly sandstones. In the Machrie Burn the proportion of conglomerate to sandstone is not so great, and in the Machrie Water there is a great thickness of soft red sandstone with few or no pebbles in what has been taken as the lower part of the upper division. W.G.

In the area to the south of the Central Ring structure, the Upper Old Red Sandstone consists largely of white conglomerates and sandstones, the latter being well exposed in the Clauchan Burn. To the south these rocks are bounded by the Carboniferous formations, but the junction is uncertain and obscure. The rocks of this area do not at first sight much resemble the typical Upper Old Red Sandstone of other parts of the island, as they are in the main white and not red. The change of colour may be due to alteration; not, however, effected by the intrusion of igneous rocks actually seen here, but by the same cause which has so metamorphosed the Lower Old Red Sandstone farther north — the intrusion of the large mass of granite and granophyre which forms part of the Central Ring area. There are some indications that even as far south as the Clauchan Burn, the igneous rocks may not be far below the present surface, a view which is supported by the fact that the plane of junction between the igneous mass and the altered sedimentary rocks appears to dip at a low angle to the southward.

In the area north-east of Cnoc a' Chapuill these beds strike north-east with a steep dip to the south-east, and often they are vertical. They consist largely of white quartzose sandstones, very fine grained and hard, with bands of pink and white quartz pebbles. In several places the rock is really a quartzite. Other outcrops in the peat are of white pebbly sandstone,



and occasionally there is some sandstone of a red colour. In the burn east-north-east of Cnoc a' Chapuill there is a band of rather hard red shale several yards in thickness, which strikes nearly east and west. Below this comes fine quartzose sandstone, and then appears a band of white quartz-conglomerate, which has a steep dip northward and must be inverted. To the north-west of Cnoc a' Chapuill there are few outcrops until the upper part of a small tributary of the Clauchan Burn is reached. Here, for a long distance, there is a continuous section in rather flaggy and well-bedded yellowish quartzose sandstones, which dip uniformly between 25° and 30° in a direction between S.W. and S.S.W. These beds apparently form the lower part of the Upper Old Red Sandstone, and immediately overlie the much-altered rocks of the lower division previously described. The south-westerly dip prevails in the section of these rocks exposed in the main stream of the Clauchan Burn, and on the hillsides to the south, and the amount generally varies between 20° and 30°. The rock is almost everywhere of a white colour; is often fine grained, and is occasionally pebbly. Sometimes, as is the case a mile due west of the Ordnance Station on Cnoc a' Chapuill, the white sandstone has a carious appearance on the weathered surface.

Lower down the main stream of the glen from the base of the subdivision there are exposed fine, evenly-bedded sandstones, mostly of a white colour, and generally hard. Farther down, the rock contains pebbles. The section is not continuous, but there are successive exposures of nearly white, hard, blocky, fine-grained sandstones dipping S.W. at 20°. West of the intrusive mass of quartz-porphry, fine, hard, quartzose sandstone, which is nearly white, reposes on slaty, red, micaceous sandstone, which has all the usual characters of the Upper Old Red Sandstone. Lower down yellowish sandstone, apparently false-bedded, dips W.S.W. at 10° to 15°; and still lower, and just above a rocky gorge, some ripple-marked sandstone dips as low as 5° to 10°. The gorge is cut in hard and thick white shattered sandstone, and a little below this is placed the fault — for fault there must be — which brings down against these beds the Triassic rocks that are well exposed lower down the glen. This fault, which has a course nearly north and south, accounts for the ending-off of the Clauchan Limestone (Lower Carboniferous) at its west end on the south side of the glen. W.G. (MS.)

### **Contemporaneous igneous rocks of Upper Old Red Sandstone age**

The Upper Old Red Sandstone of Arran contains an inter-stratified and contemporaneous set of lavas on the north side of North Glen Sannox. The area in which these volcanic intercalations occur is much faulted, but the position of the interbedded igneous rocks is quite clear. The Old Red Sandstone of this part of the island consists of three distinct members, the lowest of which is made up of coarse, well-rounded conglomerates, alternating with felspathic sandstones and purplish mudstones. These are the undoubted Lower Old Red rocks. Above this set comes a middle series of light-coloured or reddish conglomerates and sandstones, the pebbles in which are mostly of quartz. This series is apparently unconformable on the lower. Lastly comes an upper series of red sandstones and conglomerates which occupy nearly the whole of the coast section in which the Old Red Sandstone appears, and it is this series which has generally been supposed to be typical of the whole of the Old Red Sandstone of the is-land. The volcanic series is intercalated between the middle and the upper divisions above described, and it crops out in many places high above the hillside between the shepherd's house at North Sannox and Laggantuin, but is very discontinuous from being much faulted. It consists of dull-red or purplish lavas, in places soft, and often much decomposed. The general character of the rock is basic, but a specimen from near the Fallen Rocks which [Sir] J. J. H. Teall examined was found to be too much altered for precise determination, though it was probably a basalt originally. No trace of these rocks is found along the coast, nor in any other part of the island of Arran. W.G.

The three slices of Upper Old Red Sandstone lavas that are available ([S6370](#) [NS 000 480], [S9394](#) [NS 00 49], near Fallen Rocks; [S9395](#) [NR 99 48], hillside above Laggantuin) show that these rocks are decidedly more basic than those of the Lower Old Red Sandstone; and at the same time their characters exhibit an approach to well-known Carboniferous types. In spite of considerable alteration there may be recognized in the slides numerous, idiomorphic, serpentinized microphenocrysts of olivine, in a highly-felspathic groundmass consisting of oligoclase, magnetite, and decomposition products. These rocks may be regarded as intermediate between olivine-andesites, and basalts of mugearitic, Jedburgh, and Dalmeny types. G.W.T.

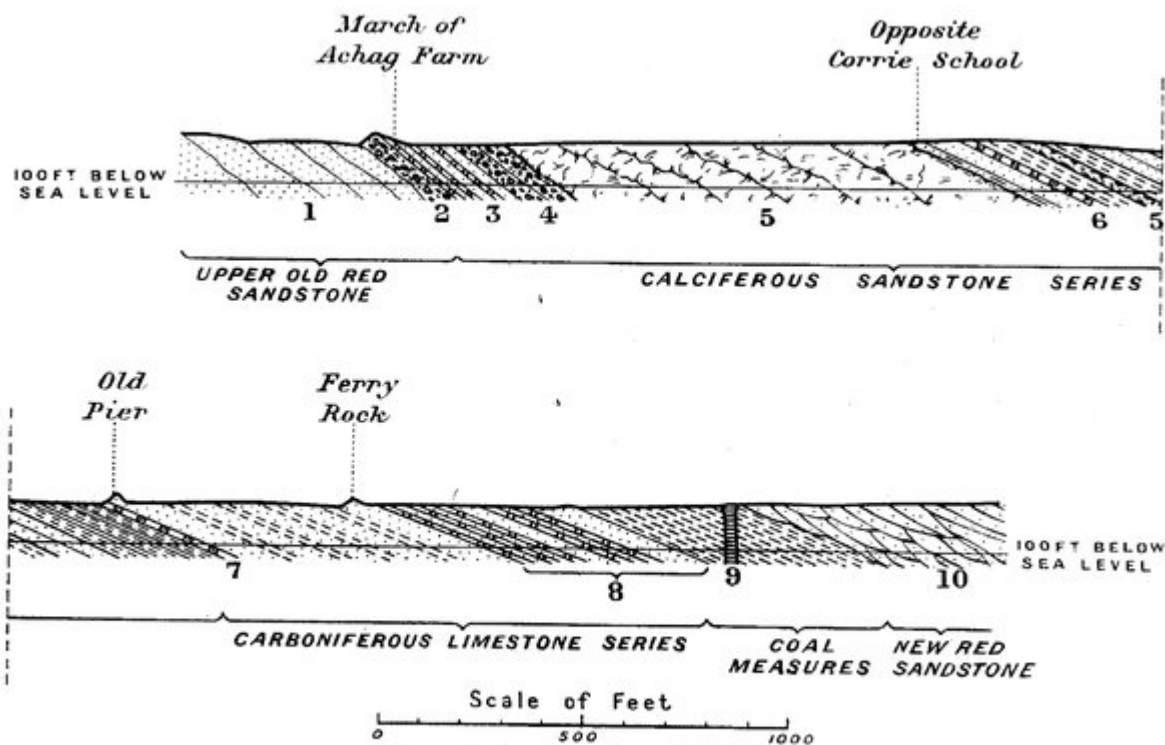


FIG. 1.—Section along shore opposite Corrie.

1. Sandstones ; 2. Conglomerate ; 3. Cornstones ; 4. Tuffs ; 5. Lavas ; 6. Limestone (red) ; 7. Limestone ('Corrie') ;
8. Upper Limestones ; 9. Basalt ; 10. Red Sandstone.

(Figure 1) Section along shore opposite Corrie. 1. Sandstones, 2 Conglomerate 3. Cornstones 4 Tuffs, 5 Lavas, 6. Limestone (Red) 7. Limestone ('Corrie') 8. Upper Limestones 9. Basalt 10. Red Sandstone.