TRANSACTIONS

OF THE

GEOLOGICAL SOCIETY OF GLASGOW.

NO. I.—FROM THE DOON TO THE GIRVAN WATER, ALONG THE CARRICK SHORE. By JOHN SMITH. With Illustrations [Plate I.], and a Coast Section.

[Read 18th October, 1892.]

THE town of Ayr is situated on a piece of flat, low-lying, sandy ground, and a considerable area in the neighbourhood is of much the same description. Immediately the Doon is crossed the surface begins to rise, and continues to do so until it culminates in Brown Carrick Hill, 940 feet above sea-level. This hill only towards its summit still answers to its colour name, which, no doubt, before cultivation had crept so far up its sides, was even more appropriate. About three-quarters of a mile to the south of the lowest Doon Bridge, is the old quarry of Burnside, at one time worked for limestone, until the "tir" became too heavy; not that it is very thick, but that it consists, where I examined it, of 5 feet of flinty chert. This chert is of a peculiar quality, being lightish-coloured, with numerous small cavities bristling with minute quartz crystals; but neither in it, nor in the underlying light-grey limestone, which is in parts crystalline, have I detected any fossils, although I have visited the locality several times.

In Burnside quarry grows in some profusion the Potato-flowered Bitter-sweet, and in an adjacent cornfield the Poor man's Weather-glass has its beautiful crimson flowers wide open; the latter we take as a happy omen for a good day in which to accomplish the long walk that is before us, and when night comes we find that we have not been disappointed. In a cultivated field near by we get

the rather scarce Buxbaum's Speedwell, and the Long Smooth-headed Poppy, and passing along by the side of a wet ditch we find the rather rare and very elegant Great Water Horse-tail, the largest native species of the order to which it belongs. By the roadside the Imperforate St. John's-Wort is in good flower, and near it is the Barren Brome-grass. On the sea-shore we find the Rest Harrow, which we observe in favourable spots, and often in abundance, all the way to Girvan.

The first rock we meet on the shore is dark soft trap, at the rifle gangway, and reaching Greenan Castle we find it to be situated on top of a small cliff of greenish, rather fine-grained volcanic ash, stratified, and with a few stones. On a grassy bank beside the Castle is the very rare Soft-Knotted Trefoil, the flowers just withered, and, along the sea margin, abundance of the Lady's-Bedstraw in good flower. The Purple Sea-Rocket is observed here and there amongst the bent and the higher shingle, and further along specimens with white flowers were obtained.

Between Greenan Castle and the Heads of Ayr the tide sweeps over strata of the cementstone group, made up of fine-grained grey layers of cement, and grey shaley beds with grey sandy plies, all dipping at a gentle angle towards the town of Ayr. In the former we find the bivalve cases of ostracods, in the latter, plant-roots and traces of other vegetation, and *Spirorbis*; fragments of scorpions have also been found in them. Cutting through these beds several dolerite dykes run seawards, two of them being known by the names of the "Deil's Dyke" and "Long Rae." About five hundred yards south of the castle is a dyke, in the centre of which is to be seen a small patch of the stratified measures lying as nearly as possible in the normal position.

The east end of the Heads of Ayr having been reached the cementstone beds are seen in a very small section nearly in a vertical position, and lying close up against the tuff which forms the Heads of Ayr, and part of the shore in this locality. Here are a number of boulders, most of them having been formed out of the tuff, but a few from a distance. At no point do we see the cement beds going under the tuff, but embedded in the latter are many bits of the cement limestone, amongst them on the shore being a piece 2 feet by 2 feet by 10 inches thick, in which are a few fish scales. Bits of limestone got in the tuff often show no

fossils, but such is not the case with this fragment, and the question is whether it has been tossed as a bomb out of a volcano, or brought to its position by other agencies. Its angles are not much worn, but many of the limestone pebbles in the tuff are well rounded.

The Heads of Ayr, which rise to, perhaps, 300 feet, are in a very decaying state, and their base towards the sea is covered with a grass-grown talus. At their western end the outcropping edges of volcanic ashbeds are seen sweeping in a curve of large radius away out to sea, and strongly suggest the idea that we have before us a section of the sloping side of a volcanic-ash cone. Whether this is so or not, the original angle of stratification must have been considerably altered, as it is now seen to vary from about 70 degrees to a nearly vertical position, which originally, under any circumstance, it could not possibly have done. The ash at the west part of the Heads is much more stony than that at Greenan Castle, though probably of the same age.

Turning the Heads we are immediately in view of a splendid patch of the Bloody Crane's-bill, and the steep rocks gives place to a long bracken-covered slope, which extends to about 200 yards beyond Brackenbrae Cot. The shore here is strewn with boulders of grey and reddish granite, probably transported from the Loch Doon district; and mixed with them are traps and a few North Highland schists. At the south end of this slope the calciferous sandstone suddenly appears, at once forming considerable cliffs, and shewing that this alteration has been brought about by a fault. The calciferous beds are here built up of conglomerates, of a reddish colour towards the base, the contained pebbles being mostly quartz and quartzite—none of very large size—with smaller ones of red jasper and lydian stone. There is much current-bedding, but the main bedding-planes are seen to lie almost horizontally. The top portion of the cliffs is of sandstone, which weathers to a reddish and whitish colour, the latter predominating, and on the rocks here and there the Wall Pennywort is at the present time in flower.

In these sandstone cliffs there are two sets of caves. The first, and the most numerous, are just above present high-tide level, the second set being situated some ten feet higher. Through the cliffs run two dolerite dykes, which pass out to sea, and towards their south-western extremity the cliffs rise to a vertical height of about 100 feet,

Appended to his "Old Red Sandstone," seventh edition, at page 365, in an article on "The Fossiliferous Deposits of Scotland," Hugh Miller says that "vast numbers" [of *Pterichthys major*] "have recently been found, though in a broken state, in the Upper Old Red Sandstone of the 'Heads of Ayr.'" We presume this refers to the calciferous beds just described, as what we know as the "Heads of Ayr" are made up of agglomerates. Opposite Lagg the calciferous beds are suddenly cut off by a fault, and are succeeded by much higher cliffs of porphyrite. On these grow numerous specimens of the Rose-root, now past flowering, though in some instances we mistake the coloured carpels for flowers.

The porphyrite cliffs at this part are about 150 feet in height, and weather to a dull liver colour, though a fresh fracture shows the rock to be greyish, compact, with felspar and a few small roundish agates here and there. The shore gravel, derived from the local rocks, also contains agates, and some one has even thought it worth while to blast the rock for them. In Lagg quarry, on the roadside, about half a mile from the shore, numerous agates have been got; and when I visited it about three years ago I saw sections of specimens 36 inches in length by 12 inches at the thickest part, with the agate only round the sides from 1 to 3 inches thick, the interior space being filled with quartz, some of it of amethystine colour, and some cavities in the quartz containing a quantity of dark brown powder (wad?). Besides the long oval cavities there was one curved (see Plate I., fig. 1), 17 inches long by $2\frac{1}{2}$ inches thick at one end and 1 inch at the other—the colour of the agate being amethyst and white. Another cavity was crescent-shaped (fig. 2), 23 inches long and $4\frac{1}{2}$ inches across at the thickest part. This agate was bluish round the edges, and had the centre filled with crystallized quartz.

At this part of the shore the cliffs cease for a short distance, and on a grassy slope there is a large patch in flower of the Hemlock Water-Dropwort. We note here, in the shore gravel, chalk flints, which are also to be found at many other parts of it. Having passed from the shore up to Braehead, the porphyrite is seen to take more of a purple colour, and the rock contains a larger quantity of felspar crystals. Hollows which have been filled with salt water and evaporated to dryness are seen covered

ROCK SECTIONS ON THE AYRSHIRE COAST.

Fig. 1.	Cavity in Porphyrite filled with Agate, - - -	Page 4
" 2.	" " filled with Agate and Quartz, - - -	" 4
" 3.	" " filled with Calcite, - - -	" 5
" 4.	" " filled with Banded Agate inside Agate - - -	" 5
" 5.	Colourless Band in Porphyrite, - - -	" 6
" 6.	Vein in Porphyrite partly filled with Agate, - - -	" 6
" 7.	Sea-stack of Porphyrite, - - -	" 7
" 8.	Cavity in Porphyrite filled with Stratified Sandstone, - - -	" 7
" 9.	Part of Cavity in Porphyrite filled with Sandstone, - - -	" 7

with minute salt crystals. Turning a corner to the left we see a bed of coarse agglomerate, under the porphyrite, and dipping towards the sea. Though only 6 feet are seen, it is probably much thicker, and is composed of pebbles of ash, felstone, and amygdaloidal trap. At this point a small patch of sandstone is interstratified with the porphyrite.

For about 500 yards to the north-east of the road which leads from the shore up to Drumbane, a bit of the old beach, which the present tide has not yet managed to carve away, still remains. We now return to the old sea-cliff, which here has got a grass-covered talus. In the rocks at the shore is a cavity 8 feet long by 3 feet 4 inches at its widest part, one side being nearly straight and the other one curved like a bow. This cavity is filled with white calcite, slightly tinged with red, and from a point near the centre of the straight side, the divisional planes of calcite crystals radiate towards every part of the curved side (Plate I., fig. 3). We pass a sea-stack about 16 feet by 12, and soon reach another one at the foot of an old road, 30 feet by 20; by the side of it are several calcite veins in the porphyrite.

The cliffs are now much lower; the porphyrite contains a large quantity of green earth with abundance of felspar crystals, many of them arranged in those curious starry clusters so peculiar to this kind of rock, and many gas cavities are filled with crystallized calcite. On the top of these cliffs, especially where there is not much soil, the Vernal Squill grows, and, as it flowers early, we find some of its seeds already ripe.

On the shore, at several parts, we passed over green "meadows" of the Grass Wrack, on which innumerable Periwinkles were feeding, and at one part of the cliffs we noted the Lesser Meadow-Rue, a very rare Ayrshire plant, and a single patch of the Honeysuckle. The Scottish Lovage was frequently seen; the Hemp-Agrimony, and the Mugwort, were not uncommon, but not yet in flower. Foxgloves seemed to be scarce, but Harebells and Wild Thyme were abundant.

About a mile to the north of Dunure, the porphyrite is again seen to contain a few agates, and we note some peculiarly horizontally-banded varieties. They generally have a thin coating of agate around the interior of the cavities, the rest of the banding being horizontal (fig. 4), and generally of a light colour. In

specimens which have been much decomposed by weathering, the layers of these varieties can easily be separated, and are then seen to be white and chalky. On the shore, passing through the porphyrite, we have seen occasional creamy-white or very pale red bands up to 6 inches wide. They look like veins of "white horse" whinstone, but are not veins at all, and simply arise from the decomposition and discolouration of the porphyrite. In the centre of these vein-like masses is seen a line, which is an original joint in the porphyrite, and from both sides of it the decomposition has started. We come to a very interesting one, where the joint has not run into the side of another joint, but has terminated in the solid rock, and the decomposed vein-like part, which is $2\frac{1}{2}$ inches wide, also terminates about an inch beyond the joint (Plate I., fig. 5). In these altered parts of the rock the amygdaloidal cavities are mostly found to be empty, and though the felspar is much altered it still occupies its place.

A little nearer Dunure the porphyrite is very compact, and is purplish in colour, glittering where washed by the tide. Some of it is very much jointed, the joints running through it in every direction, and is duller in colour, without the glitter. At several places we noted thin veins filled with impure agate, but here some of the agate veins were comparatively pure, and whatever might be the colour of the centre, those we examined, at least, began with a thin red layer on each side. One we observed, an inch thick, is at a certain point of double thickness (fig. 6), but we think the crack must have been of this form before the agate was filled into it.

There are here a number of sea-stacks, and one of them, about 20 feet high, shows the rock-jointings running in a very peculiar curving manner (fig. 7).

After passing some low-tide rocks covered with *Balani*, we arrive at Dunure fishing village, situated almost on the sea-shore, and well sheltered by the rising ground to the east. By the roadside, close to Dunure, or "Port Rorie" as it is sometimes called, lies a thick bed of green conglomerate, some of the pebbles in it reaching a diameter of over a foot. At the old castle of Dunure, which stands on a cliff overhanging the sea, the rocks contain agates, some of them of considerable size, and much the same in character as those in Lagg quarry.

In this immediate neighbourhood are some curious infillings in the porphyrite. We have observed this peculiar deposit in cavities all along the coast, but not nearly to such an extent as here, and it occurs further along wherever these rocks are exposed. The Geological Survey Officers (in the "Explanation" to Sheet 14) thus describe them and the cavities which contain them:—"Throughout the porphyrites of this group, irregular vertical veins of sandstone traverse the rocks in a stellar arrangement. The sandstone is horizontally stratified, and agrees in character with the sandstone lying between the porphyrites; whence it appears that these veins are due to the sand which was washed into the irregular star-shaped cracks of the cooled lava, before the lava was covered by the next stream of molten matter."

I had observed these peculiar infillings before I had read the Geological Survey explanation of the occurrence, and even when I had read it I was rather sceptical as to its validity. However, after further microscopical examination of several samples, I am now quite satisfied that the infilling material is sandstone, and that the official explanation is the correct one. This sandstone is very fine-grained, and is deposited in thin layers, the bedding planes being dusted over with numerous mica scales. The cavity deposits are greyish, greenish, or dull-purple in colour, and are sometimes so fine grained as to deserve the name of shales. They present in many cases a hardened, indurated appearance, no doubt due to the next sheet of lava which was poured over them. They are not all horizontally bedded as the "Explanation" says, for I noticed some inclined at a considerable angle; but this is just what we might expect from the peculiar method of their infilling. Hundreds of them can be examined along the shore, and in no case did I find any to be coarse-grained. The porphyrites, whether poured out under fresh or salt water, seem to have been deposited in deepish, still water, where the currents were not strong enough to carry along anything but very fine particles. I should not be at all surprised if organic remains should yet be found in some of these very strange deposits. Figs. 8 and 9 (Plate I.) will give some idea of their appearance in side section.

At, and below, Dunure Castle there are large stacks of rock in the sea; and to the south of this point the water comes closer up to the base of the cliffs than it does to the north. There are also

more caverns in the rock, but into none of them do the tides appear to enter now. We observe that the inner ends of some of these old sea-caves are provided with funnels opening upwards to the grassy surface on the top of the cliffs, and at the time when the sea entered them, these would, during storms, act as immense blowers, sending forth tall jets of spray.

“ See the thundering cliffs below,
How they snort and how they blow.”

To the south of Dunure Castle there are many gas cavities in the rock, most of them filled with crystallised calcite, and a few with agate. About half a mile from it there is a fine display of four Raised-beaches cut out of the solid rock, but now covered with grass. They appear to occupy levels of about 10, 20, 30, and 45 feet, respectively, above the present tide-mark, and they run for perhaps a quarter of a mile, the last mentioned being 20 to 30 yards broad, and the previous one 50 to 60 yards.

At the end of the beach area described we find the Common Skullcap, a rare Ayrshire plant, growing and flowering amongst the upper gravel. The Crested Hair-grass is common all along this shore, although it is very scarce in the north of Ayrshire. We find here, too, the Greater Prickly Carex, and the Hairy-Tare, both rather scarce plants.

South of this the rock is very amygdaloidal, the gas cavities being filled with calcite, and we see some old caves about 20 feet above the present sea-level. We come to a place where the porphyrite is very dark-coloured, and the cavities nearly all filled with agates, small in size, but many very beautiful. At a point where an old sea-stack is seen standing amongst the grass, there is growing on the face of the cliff directly opposite, a large plant of ivy. As far as I could calculate it covers an area of perpendicular rock-face of about 1000 square feet, and springs from a single thick, twisted stem. The old sea-caves are the resort of many ringdoves, and as we pass along some of them get disturbed and begin their flight by that peculiar wing-clapping so characteristic of the species.

A short distance below Drumshang the porphyrites end, and below them slips what is thought to be the middle division of the Old Red Sandstone. We have thus traced these rocks along the shore for a distance of 3 miles. In this part of Ayrshire they

cover an area of 9 square miles, extending to beyond the Doon, near Auchendrane, and rising at one point, in Brown Carrick Hill, to a height of 940 feet above tide-level. Exceedingly few dolerite dykes run through them, and on the shore only some two are seen. But this is a feature which is characteristic of igneous rocks, and perhaps shows that in cooling they do not undergo so much shrinkage as aqueous rocks do in drying.

In passing along the shore from near Drumshang to Culzean Castle we find the outline of this Old Red Sandstone district much softer, the cliffs being so much cut away that the rocks seldom reach the shore; and only here and there are the old coast-line sandstone cliffs to be seen, with grass-covered talus, and capped in places by reddish Boulder-clay. The sandstone cliffs are at first seen weathering to a yellowish colour, and the grassy slopes are traversed by those curious horizontal walks, the work of sheep. A short distance to the north of Croy little farm-steading there is a considerable outcrop of conglomerate. It is rather coarse, and of a greenish colour: this hue being derived from the large quantity of Silurian mudstone pebbles it contains, some of them running up to six inches in diameter. It also contains a few greyish Silurian limestone pebbles up to 12 inches. These are of very pure carbonate of lime, some of them with a slight tinge of red crystalline calcite, and from one pebble I obtained two fossils. This conglomerate also contains pebbles of reddish syenite, red jasper, and lydian stone, some of the latter being rather angular. Interstratified with it are a few thin grey sandstone beds. One under it is a bed evidently softer than itself, as the conglomerate has been much undermined, and large blocks of it are now lying on the higher part of the beach.

For a short way the shore is sandy, and we see early potatoes are being dug from a field which is neither peat, sand, nor loam, but literally a bank of coarse gravel. The man who was working amongst them informed me that the seed potatoes are laid in open wooden trays, put in an outhouse during the winter, and allowed to sprout about 5 inches before they are planted—the small ones being selected for the purpose, and not cut, but planted whole. By this method the crop comes to maturity three weeks earlier than it would do if the seed-tubers were treated in the usual way, so that it is ready for the early market, and fetches a high price.

Before coming to Rancleuch the sandstone cliffs are seen to have

weathered into yellowish and reddish hues, and, at Goatsgreen, the rock is mostly obscured by trees and vegetation. On the side of the road which here ascends from the shore there is a bank of the rare Wood-Vetch, the finest of all our tares, and at the present time it is in splendid bloom, while further along we find the Enchanter's-Nightshade in flower.

Close to the shore we pass three very light-coloured dolerite dykes, and between two of these the sandstone beds are seen to be somewhat twisted. At the north end of Culzean Castle buildings, which stand on the summit of a high cliff, the porphyrites, by a fault, are again suddenly brought to view—the Old Red Sandstone cliffs having been cut about 100 yards further inland.

In the porphyrite under the Castle are several old Raised-beach caves, into which the tide does not now enter, and some parts of the rock are much cut up by natural jointings, which run through it in every direction. At the south end of the Castle grounds a wooden gangway leads on to a sea-stack, the rock of which is very amygdaloidal, and at its base a coarse agglomerate is seen dipping seawards at a angle of about 15° . The Castle itself is built of a fine-grained yellowish stone, obtained from the Old Red Sandstone formation of the neighbourhood. At the laundry the rock is very amygdaloidal, with many infillings of sandstone. We note a large oval cavity here 3 feet long by 10 inches at the widest part. It is filled with crystallised quartz, and in the quartz are a few crystals of calcite. Another cavity beside it, 3 feet by 18 inches, is filled with chert or hornstone, and calcite. In some cavities we have observed the chert is very solid, of a pale-greyish colour, and not unlike some varieties of flint.

At the little stream which comes down from the pond we find the rather rare Lesser Panicked Sedge, which in spite of its name is about four feet high, and on permanently wet parts of the sands we observe the scarce Shore Whorl-grass.

The porphyrite cliffs end at about a quarter of a mile north of the Culzean Home, and the land rises in gentle terraces, the old sea-beaches, inland from the sandy shore of Maidenhead Bay. The porphyrites are now seen in the bay as sea-rocks which are known as "the Maidens." About half tide they are rather picturesque, though not high, rising into rocky points and bosses.

Romantically situated to the west of some partially grass-covered

old sea-rocks are the remains of the Douglstone shipbuilding yard, a site evidently chosen more from a philanthropic than from a commercial point of view. We are again among the porphyrites, the rock being very amygdaloidal, in parts containing numerous agates. One we dig out is of a strange pattern; with minute figures of white agate of innumerable shapes, infilled with green earth, a little red jasper, and some purple patches. Between this and the old Castle of Turnberry and the Light-house the cliffs are not high, but are very much cut into by the action of the sea; we notice that the porphyrite contains the sand infillings, already more than once referred to. At a short distance from Turnberry, we note, dipping seawards under the porphyrites, a few feet of a grey ash-bed resting on sandstone.

Very little remains of Bruce's Castle at Turnberry, part of the north wall built of red sandstone being, perhaps, the most prominent feature. Onward from this the porphyrites are of a dullish-purple colour, very amygdaloidal in parts, with agate veins, and they run under the sea at about 400 yards south of the Light-house. For more than a mile the shore, which holds eastward now, is covered by bent-grown sand-hills, rising to little more than 20 feet above tide-mark. About a mile seaward from the shore we observe a long line of low rocks, stretching in a north-east and south-west direction. They are called the "Breast Rocks," and, from information supplied by two fishermen, we come to the conclusion that they must be porphyrites, and a continuation of those we last saw at Turnberry Point.

For a considerable distance there is now a good wide breadth between the shore and the old coast-line, which in parts is bounded by

high and sloping grass-covered banks. We are now traversing the lower division of the Old Red Sandstone formation, which, for the most part, is hid by sand-drift; though at some places we note the purplish-red beds of sandstone just rising above the shingle of the beach, and quite different in colour from the sandstone rocks to the north of Culzean. In the Girvan Mains quarry, which is quite close to the shore, this rock has been to some extent worked for building-stone, but the excavations are at the present time partly filled with water.

In a ditch close by the quarry the Great Hairy Willow Herb is growing in profusion, and a few of its fine purple-red flowers are already opened, while on the bent-covered sea-margin a few plants of the Sea-Holly are to be seen, but not yet in flower. This is the land of the early potato, and from many fields the crop has been already lifted, but where it still remains we observe that the Small Nettle is about as abundant as the potato plants themselves.

At one part of the beach, beds of red sandstone and conglomerate are seen dipping towards the south-west at an angle of about 20°. From the end of the sand-hills to Girvan Water numerous boulders are met with, and the beach is at several places much covered with them. The majority seem to be granites from the Loch Doon district; they are well rounded, and many are of considerable size.

The day has all along been delightfully clear; the bold outline of Arran stands sharply out against the western sky; the southern part of Kintyre, though fainter, is not at all obscured; Ailsa Craig, "the ocean pyramid," is nearer-looking than it was in the morning; and the Ayrshire coast beyond Girvan is seen rising gradually from the sea, swelling into rounded bosses, till it culminates in hills of considerable height, which are built up of rocks very much older than those we have just traversed.