Cumbrae Island Saturday 30 April 2011

Geological Society of Glasgow day excursion

About 20 members of the society met in bright sunshine at the ferry terminal of Cumbrae Island, at 10.45 a.m. Our purpose was to study the Upper Old Red Sandstone, and the Lower Carboniferous marls and sandstones. Tertiary and Carboniferous dykes, which intrude into the sediments, are well exposed on the Island. Several of these were visited.

The reader should refer to the map (figure 1) and cross section (figure 2), included here from Dr. Keen's notes, for details of the locations which we visited.. Our leader, Dr. Mike Keen also prepared a summary of the geology of Cumbrae, based on reference 1, for us to read before we set off to our first location. (reference 8).

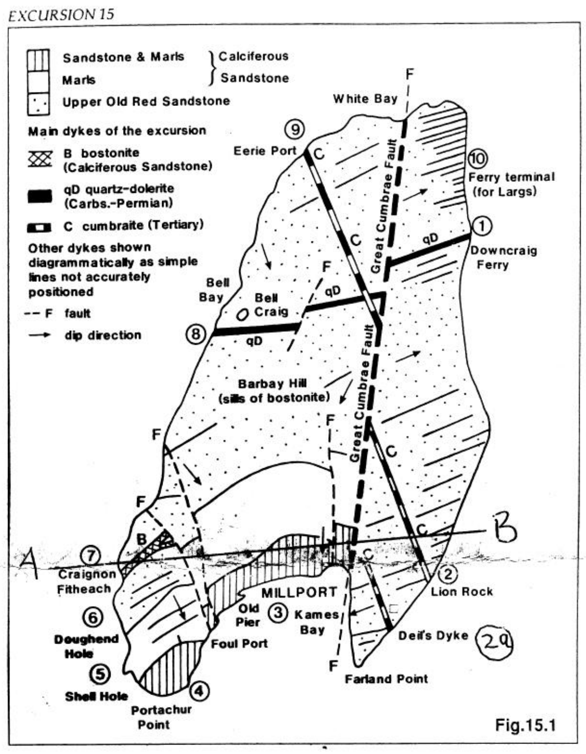

Figure 15.1. Simplified geological map of Great Cumbrae.

Figure 1

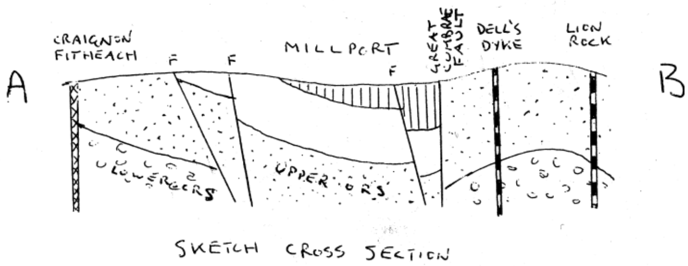

Figure2

The Island consists of Old Red Sandstone fluviatile sediments on the north and west part of the island, separated by faulting from the Lower Carboniferous sediments of the south part of the Island. (reference 3a, 3b).

A conspicuous north-east to south-west fault, the Great Cumbrae Fault, runs from Kaim Bay in the south of the island to White Bay at the northern extremity of the island. This fault, and its associated dykes, forms a cliff about 30 m high, in which a narrow strip of the Old Red Sandstone strata is uplifted above the surrounding landscape. It has its origins in the Caledonian orogeny (reference 6, p. 36).

There are two main sets of dykes. The Carboniferous dykes run approximately east-west (reference 6, p.32). These are centred on Arran, where the granite mountains are easily visible from Cumbrae Island. The Tertiary dykes, which radiate from the vicinity of Mull and Skye, run mostly north-west to south-east (reference 6, p.35).

Our first stopping point was Lion Rock (location 2 on the map, photographs 1 and 2). This is one of the Tertiary dykes. It consists of Labradorite with anorthite feldspar crystals (reference 5, p.36). The exposure of the dyke above the surrounding landscape is due to erosion in past times, when the sea level was 10 m higher than it is at present. (photo 1). The raised beach and former cliff line, which is the result of isostatic rebound of the land after disappearance of the ice 8000 years ago, is well displayed in the vicinity of Lion Rock. Below Lion Rock, the Upper Old Red Sandstone was exposed. Here, it was possible to observe the crossed bedding and pebble clusters typical of high energy, fast flowing, intermittent flooding. The redness of the rocks indicates a sub aerial environment in which the iron content was well oxidised. In some places, yellow joints indicated partial hydration and reduction of some of the iron. The group examined these features (photo 2).

1. Lion Rock

2. The group below Lion Rock

On our way to our next location, we passed the Marine Biology Station, at "De'il's Dyke", another Tertiary intrusion (location2a on the map). This also stands proud of the eroded Old Red Sandstone and the associated raised beach.

We arrived at the north west corner of Kaim Bay (location 3 on the map), where the abrupt erosional horizon between the lower marl beds and two upper sandstone beds (the Millport Sandstone) is visible in several exposures of the rocks on the shore just below the pavement. The white sandstone there is coarser than that of the Old Red Sandstone. The two sandstone strata are like those of a sand bar. Again, crossed bedding indicates a braided fluviatile system. The total thickness of the sandstones exposed here is about 2 m.

The junction between the marls and the sandstones was of particular interest. The abrupt change may have been caused by uplift of the source of the sandstone, or the braiding of the rivers which supplied the sediment. The pebbles at the interface, and the irregular nature of that interface, indicate a fast flowing high energy environment. Caliche formations (photos 3 and 4) are indicative of periodic flooding followed by percolation and subsequent precipitation by evaporation.

3. Caliche formations at Kaim Bay

4. Caliche at Kaim Bay

Caliche, sometimes called "calcrete", consists mostly of calcium carbonate, with minor additions of other elements such as magnesium and iron. The marls beneath the sandstones are made of coarse grained red siltstone, in which calcite "partings" and green reduction spots are evident. The few pebbles in the marls are concentrated into thin horizons. These two features show periodic rapid flooding followed by arid conditions, such as is found in present day wadis and sabkhas.

Our next port of call was Eerie Port (location 9 on the map), where, on the shore above the high tide level, across the road from "Osprey" holiday apartments, a continuation of Lion Rock appears. This is the Cumbraeite dyke. It consists of a ground mass of Labradorite in which phenocrysts of anorthite are present. (photo 5).

It is of Tertiary age. The jointing which is caused by rapid cooling, and the glassy nature of the ground mass of the dyke, shows near surface emplacement of the lava. The bleach zone in the surrounding Old Red Sandstone Strata is narrow, and is of low metamorphic grade.

5. Cumbraeite at Eerie Port

We returned to Foulport Bay (between locations 3 and 4 on the map) for lunch. The maps given by Young and Caldwell (reference 7) show this area in detail. The strata here are part of the upper Old Red Sandstone/Lower Carboniferous Kinesswood formation. This cove, just south of Millport, is bounded by two north-west to south-east trending faults. The rocks on the south west side of the faults show considerable displacement southwards relative to those on the northeast side. Those on the north east side of the bay dip 45 degrees south east, and consist of alternating marl and sand/limestone beds with algal growths (the Ballagan Beds). Those on the south west side also consist of alternating marl and sandstone and dip at 45 degrees, but, additionally, have ripple marks, coarser clasts, and wider spacing between the coarse beds. At the landward end of the bay, are the Foulport Marls, which are lower in the stratigraphic succession than the Ballagan Beds. On both sides of the cove, the beds transform upwards at the seaward end into the sandstones, which reach a thickness of over 10 m.

Most of the afternoon was spent on the beach to the south of Westbourne Hotel, near Portachur Point (locations 5 to 4 on the map). At Westbourne, two small dykes form a small cove. On the north side of the cove, the Upper Old Red Sandstone strata show the usual crossed bedding. Some time was spent studying the clasts. The sandstone is matrix supported. The pebbles are almost all quartz, with some gritstone and slate/mudstone pebbles (Dalradian?). The sizes were variable from mm size to cm size. The well rounded nature of the quartz, and the few examples of other types of pebble suggest a distant source, possibly even reworked material. The poor sorting of the pebbles, and their sporadic occurrence, suggest an intermittent high energy environment. Above the Old Red Sandstone layers, there exist horizontal beds of a paler, more limey, sandstone. These could be part of the transition in the Kinesswood formation from the Upper Old Red sandstone to Lower Carboniferous formation. This succession is also well exposed across the water at Kilchattan Bay, Isle of Bute.

At the cove at Westbourne, the raised beach and the old cliff line are plainly visible. In several places, where human or animal activity has disturbed the ground, the shell beds are visible. These formed a shallow water area just below the old cliff line, before isostatic rebound caused uplift and formed dry land. Many of the shells are of present day species. A few indicate a short period when the sea was one or two degrees warmer than at present. Others are of a sub-Arctic species long departed from our shores (reference 5, pp. 48, 79 to 80).

South of Westbourne Cove, the first item of interest was the stromatolite bed.

6. The Stromatolite beds at Westbourne

These blue algae gave the strata an undulating, nodular appearance, which can be seen in photographs 6 and 7. The rocks are of lower Carboniferous age.

7. Close View of Stromatolites

South of the stromatolite beds, towards the Telephone cable Marker Post, the beds are marls with intermittent coarse sandstones. Ripple marks, desiccation cracks, and precipitation of calcite all appear in several different places. These all indicate a warm, shallow water environment. These strata are, however remarkably free of fossils apart from more possible algal beds.

Livingstone (4) points out the interesting dykes which can be seen on the shore at more than two hours either side of high tide. At the path to the shore just north of Westbourne, a basalt dyke forms the south side of the path. This dyke has been offset by a fault on the shore. Beyond the fault, the dyke continues its south-west trend. The north-south trending dyke which forms the seaward edge of the fields is the only tholeiite dyke on the island, and is apparently the only one with a north-south trend. It is offset to the southwest by a fault about halfway along its length. It also cuts an older north-west trending crinanite dyke below high water mark. Livingstone (4) comments that

the direction of the tholeiite dyke points towards the southern tip of Arran, where a sill is thought to have been the source of the dyke. At several places, vesicles were present in the tholeiite dyke (photo 8). This suggests a near surface intrusion of the magma. It is possible that this dyke is a late Carboniferous quartz-dolerite like that at Millburn (reference 6, p.34).

8.Vesicles in the N-S Dyke

The sandstone above the dyke consists of two members.

The lower one shows small faults and drape structures. The upper member shows none of these features. Although a disconformity between the lower and upper members was not evident, the upper member must have been deposited some time later than the lower one. Strata under the dyke show similar behaviour (photo 9).

9.Fault and drape structures above the theolite dyke

About 100 metres north of the Telephone cable Marker post, the dyke appears to come to an end, and the strike of the marl/sandstone beds swings round from a north-west strike to a south-west strike. Also,a large, apparently slumped, massive yellow sandstone appears, with a north-west strike and 45 degree dip to the south-west (photo 10).

10.The Slumped Sandstone

The whole structure (photographs 11 and 12) at the south end of the tholeiite dyke appears to be a small basin into which sediment has accumulated, with the characteristic thinning towards the edge of the basin.

11.The Basin Structure

12.Basin seen from a high vantage point

Much discussion ensued about the nature and cause of the large sandstone mass, the disappearance of the tholeiite dyke, and the basin formation.

The ripple marks are again present in nearby strata, with the same spacing as that of those observed further back towards Westbourne. The layers above the ripple marks bear a remarkable resemblance to those just north of Foulport Yacht club, and to those just below the sandstones on the south side of Foulport Cove. A remarkable square jointing is present in white fine grained sediments at all three places. These thin finer grained beds coarsen upwards into thicker sandstones. The marl beds disappear. At the south limit of our visit, the stromatolite beds reappear. The shallow northerly dip of the strata near Westbourne is complemented by a similar shallow southerly dip in the region of the Telphone Cable Marker Post. The whole region from Westbourne to the Telephone Cable Marker post is a shallow antiform.

We returned to Westbourne, where a vote of thanks was followed by well-earned applause. Our thanks go to Jim Martin and mike Keen for an interesting day on Great Cumbrae Island.

Finally, we headed back towards Millport, still in bright sunshine, for a much needed ice cream.

David B. Hollis, 5 May 2011.

Further information is found in the excursion guide to the Glasgow area (references 1a and 1b), the British Geological survey Regional memoir for the Midland Valley of Scotland (reference 2), and The Geology of Scotland (reference 3). A short monograph, by Peter Livingstone (reference 4) gives an excellent introduction to the geology of Cumbrae Island. Young and Caldwell (reference 7) give stratigraphic maps and references to localities 3 and 4 of our itinerary. References 5 and 6 give more detailed information

Figures

1) Map of Cumbrae, showing major dykes and locations of features.

(after ref. 1)

2) Cross section A-B west to east of Cumbrae

(after ref. 8)

Photographs

1) Lion Rock

2) The group below the Lion rock

3) Caliche formations at Kaim Bay

4) Caliche at Kaim bay

5) Cumbraeite at Eerie Port

6) The Stromatolite beds at Westbourne

7) Close view of the stromatolites

8) Vesicles in the north-south dyke

9) Fault and drape structures above the tholeiite dyke

10) The slumped sandstone

11) The basin structure at the south end of our visit

12) The basin structure seen from a high vantage point

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P. 35 Tertiary dykes

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