A self guided geology excursion in the city of Bristol using accessible paths

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Introduction

Following requests to have any compulsory element of field work removed from university geology courses (in order that they might be more inclusive), I began to look for sites where access was good and rocks could be reached by the less agile, studied closely and ideally touched by a wheel-chair user because we all know field work experience to be absolutely essential.

The footpaths and all-weather surfaces around the Clifton Suspension Bridge and the nearby playground provide good access to a range of important geology. Some paths are rather steep, but the main ones are on the level. The rocks are mainly Carboniferous Limestone, of the uppermost informal division of the Clifton Down Limestone Formation often referred to as the Concretionary Beds.

Alongside features and textures of limestone rock there are some excellent fossils, a variety of joints, faults, veins and minerals. There is an area of anomalous dip which may be due to localised folding and unconformable rocks of Triassic Age can also be seen.

Although open to public access, care is still needed for the usual hazards especially given the proximity of roads. Although the cliff faces are not high and reasonably stable the odd stray falling rock should not be ruled out.

Detailed Itinerary

Figure 1, see below, shows a map of the accessible paths and adjacent exposures and features in the Observatory area of Clifton Downs and nearby paths leading to Brunel's Suspension Bridge.

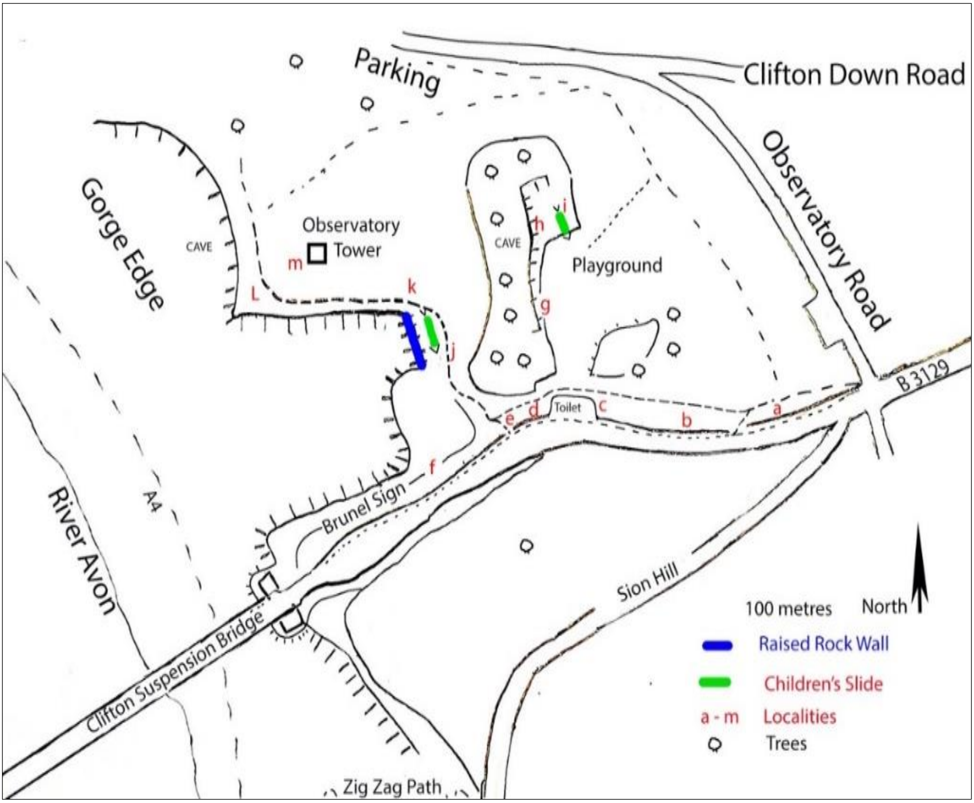


Figure 1: Localities along the suggested tour route.

a – f: Level foot path up to the Suspension Bridge - extending across it & back
Loop across the suspension bridge and back is covered in separate itinerary.
c: Sitting area for the café where there are toilet facilities.
e – m: This section of path is very steep and there is a step.
j: The path here is tarmac but very steep.
k – m: Best accessed from the parking on Clifton Down Road, moderate slope
g – i: Playground has all-weather surface but the quarry face and bedding planes are on rough soil - best accessed from Clifton Road junction
a – g: Return from playground to start is a medium slope.

Some pay and display parking on Sion Hill and along Clifton Down Road.

Localities 'a', 'b' and 'c' from R to L View: looking north; the toilet block is just left of picture.

Begin by walking west along the foot path towards the Suspension Bridge, starting across the road from where Sion Hill joins and the low rock face begins.
After passing small well exposed bedding planes showing true southerly dips, arrive at the start of the 2–3 metre high rock face. Notice the predominant jointing pattern and apparent dip in the seemingly uniform and uninteresting grey limestone well exposed in this section leading up to the bridge foundations. Pause @ 'a' to look for a narrow near vertical open 10cm fissure that cuts the bedding and is partly eroded out to form a slot. It is seen to be filled with a vivid bright red mud and a sample of this loose material was collected and washed. Although no bone or teeth fragments were recovered some noticeably dense centimetre sized chips revealed black haematite and good quartz crystals, in effect minute Bristol Diamonds.

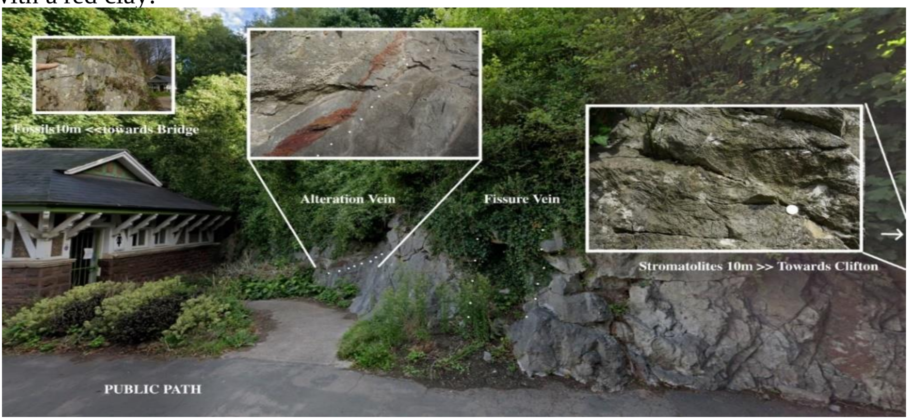
Please leave any larger lumps present for others to feel how noticeably heavy they are but beware - these oxidised iron minerals stain skin and clothes deep red.

Approximately halfway along the face to the toilet block notice @ 'b' high up on the face faint convex lines consisting of concentric ridges and indentations. These are stromatolite fossils weathering differentially. They are not much to look at but the same kind of micro-organisms that trapped the sediment to made the convex shapes were also alive billions of years ago and provided the oxygen that kick started animal life on the planet – Stromatolites are also found in rocks of a similar age in Cheddar Gorge and in much younger rocks also in the Bristol area called Cotham Marble. Living stromatolites are still to be found today making similar shapes in Shark Bay, Australia. Try to trace the stromatolite bed down dip to where a small section has been polished. The internal structure can be seen more clearly but in this bed it is not so distinctly undulating.

Locality b

Bed of unpolished stromatolite with curving laminations resting on polished older bed.

A little further west a protruding triangular bock is a good place to observe the difference between true dip and apparent dip. Nearby is another obvious narrow near vertical parallel sided slot (another weathered out mineral vein). At the corner, before the embayment of the face for the toilet block, there is another slot in the face but this time the weathered out gap is not vertical and there is a very small cave, partly infilled with a red clay.



View of the rock embayment cut out to accommodate the Victorian Toilet block.

Localitiy c

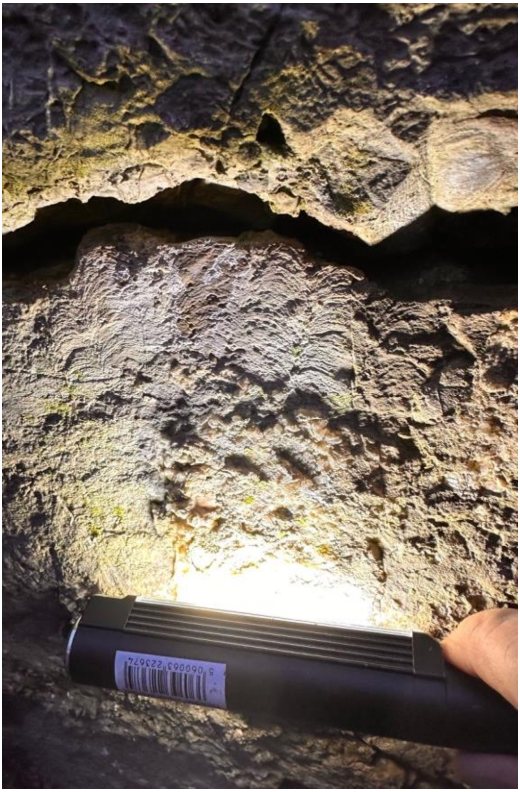
In the wall of the setback face @ ‘c’ look for totally different kinds of mineral veins. Notice the difference of a fine branching sinuous orange/red vein with low dip. Decide if this is also due to a tectonic crack or has the rock been altered by mineralizing fluids spreading out from a non-linear vein. Linear veins fill tectonic fissures and look for a wider crack filled with coarse crystals. Although blackened by pollution typical rhombohedral cleavage can be made out indicating that calcite is present.

Locality ‘c’: thin red vein spreading out and mineralizing the limestone on either side of a sinuous line, on N-S Toilet block face. Black and yellow torch pointing to vein is 20cm long.

Locality d

On the face on the far (west) side of the toilet block look for the end of the wire netting. Partially hidden by the netting, is a large colonial coral with thin tubes and nearby are beautifully preserved if tiny stromatolites.

Plate 5: locality d: Colonial coral almost obscured by rock netting 2mm wire for scale.



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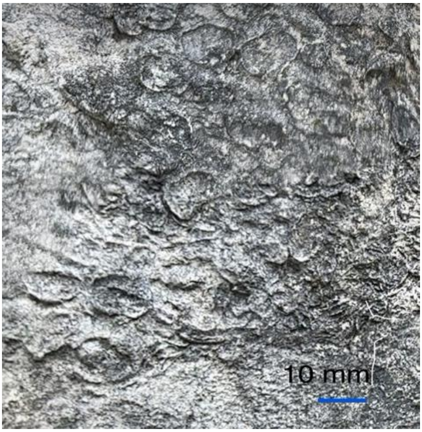
locality d: millimeter concentric growth lines of Stromatolite fossils, finger holding torch for scale.

A little further along the lower half of the face bulges out, here look on this grey convex surface for slightly protruding circles the size of a little fingernail. Close inspection reveals ridges radiating from the center of each circle. A small section has been polished to reveal these fossils in cross- and longitudinal section. The polished matrix limestone has changed from grey to an unweathered dark pink.

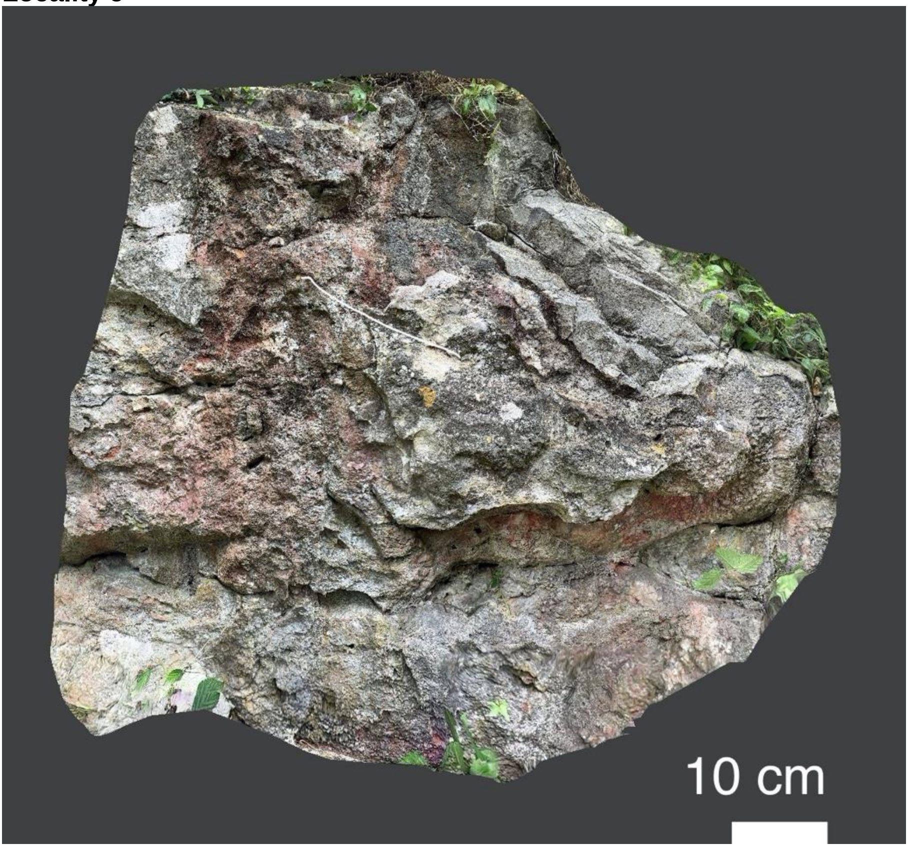
Between locality d and e

Two different areas of rock from the same face – on the left showing particularly clear weathered coral colony and, on the right, a polished portion showing coral cylinders with radial septal walls in a red pisolitic (?) limestone matrix. Door key for scale



Further along the face before reaching the side path look high up for a 1 meter section of a vertical joint face of a single bed showing many similar but slightly larger protruding ring shapes. These, however, are much more numerous and are sections through elliptical shells. The shell shape (with two symmetrical valves but of inequal size) proves that these belong to brachiopods – Try to decide if these are a death assemblage accumulated by currents of were a group of living individuals sometimes called brachiopod nests.

Locality e



e: where the path goes through a gap in the face look for a wide fissure fill deposit and a branching calcite vein. This has been part cleaned to show the white mineral below centuries of back urban smoke pollution.

This side path is rather steep and has a step and is not suitable for wheel-chairs.
Proceed to the bridge.

Locality f

f: near the seat and the plaque to Brunel try to find an unconformable junction with overlying Triassic Dolomitic Conglomerate (now called Mercia Mudstone Marginal Facies or MMMF for short!) sadly this is rather disappointing. Far better examples can be found further north on the gorge edge but in generally rather dangerous inaccessible places. A small garden, created by staff of the University of Bristol Botanical Garden, is given over to plants typical of the rich Limestone flora of the gorge.

From here it is a good idea to loop across the bridge and upon the return, try to look over the parapet wall to gain a view of the full face of the Avon Gorge – You may need help to do this because the wire safety netting obscures the view from a wheel chair. Looking from across the river the face shows an excellent section of the dipping massive beds of the Clifton Down Limestone and also some surfaces which at first may appear to be bedding planes but are in fact thrust fault planes, although many thrusts migrate to become bedding plane slides. There are also very noticeable near vertical surfaces that are red stained. These are later normal faults, and it is tempting to try to reconstruct the time before these faults moved. A paper in *Nature in Avon* Vol 80 by R Arthur suggests that one possible reconstruction would return all the separate thrust surfaces as one if the slip on the vertical faults were reinstated prior to the off-set. It will probably take a rock climber to confirm if this theory is correct. Also, a drag fold is described in the same article but is only seen now and then if the conditions are right. This may be the reason that prior to the Arthur paper the fold does not seem to have been recorded.

Return to the start but if time permits, and gentle slopes are not an insurmountable obstacle, take the sloping path to the Playground. It may be simpler to use the alternative path from Clifton Down Road.

Locality g

g: The playground is sited between a small rocky bluff with indistinct bedding and an old quarry face with massive beds clearly seen dipping from right to left i.e. south at 30 degrees.
A bed crowded with 'nests' of brachiopods in a few places comprises almost all of the rock. This is best seen at some height in the face, which is not ideal for our easy access tour, but the same bed does reach ground level some 5 metres to the right of the bricked up old 'adit'.

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Polished block from a 1 meter thick bed 5m North of the bricked up cave or adit in the quarry face near the playground. Note that it is crowded with articulated 'bi valved' shells with a brachiopod not lamellibranch symmetry set in a very fine-grained limestone matrix notably not obviously Oolitic or Pisolitic. These fossils have many charistics in common with Seminula, now Composita, but their stratigraphic position here is much younger than the classic Seminula Oolite and Seminula Pisolite in the Great Quarry. These beds are much nearer the Base of the Clifton Down Limestone which far older.
The BGS memoir marks a seminula pisolite on their stratigraphic column, which is all rather confusing.

Oposite: the brachiopod *Seminula*, now *Composita* Vaughan 1903. Identification images for this famous fossil are hard to track down. This image is from "*Note on the Corals and Brachiopods obtained from the Avon Section and preserved in the Stoddart Collection*. *Proc. Bristol Naturalists' Society NS* 10(2), pp. 90-134, 2.

Locality h

h: The north face of the quarry is formed by a series of distinct single sloping bedding planes rising-up from the old quarry floor. The bedding surfaces show some eroded/weathered out weaknesses mostly orientated north–south. These are joints but there is also perhaps some faulting. These fractures are in the same orientation as the weaknesses that were exploited to create the gorge.

Locality i

i: Two bedding planes rise up from ground level to form low stepped slopes and the younger of the two surfaces has a polished depression (a smaller version of the famous children's slide nearby this is more accessible than the main slide although traversing these slopes is not really possible for the able bodied). Crossing this polished surface is a fine example of mineral filled en-echelon tension gash veins.

En-echelon tension veins. A series of thin lozenge shaped white marks in a staggered line crossing a prominent bedding plane polished by the action of children's shoes in a smaller version of the larger more famous slide. (Keys for scale)

The vein set is at an angle of about 30 ° to the steepest slope – the true dip direction. A barren joint lies sub-parallel to this trend. A second set of indistinct wispy un-thickened thin veins sub parallel open joints and are orientated in the opposite direction. These define the classic and very common X shape, typical of 60/30 brittle fracture. This is the same orientation and pattern of scratch marks seen deep in Aveline's Hole often attributed to Neolithic art. Were these prehistoric peoples inspired by geology or are the marks actually geological in origin?

This vein structure is caused by a shearing action producing a staggered line of cracks. Further shearing opens these cracks to form oval slits which were later in-filled by a mineral, usually quartz or, as here, calcite. The feathered out ends of these slits are often dragged by further movement making a sigmoid and these structures are useful for calculating the stress fields due to Variscan compression.

From here return to the start or the fit and those wheel-chair users who can summon two strong pushers can tackle the short but very steep path to the Observatory Tower – descending this path also requires two helpers to avoid run-away.

Localities j, k, l and m

j: Halfway up the slope (or from the top) a good view of the main children's slide some white fossils can just about be made out. On dry days it is just possible for the agile to walk up the slide and observe these superb, polished fossils or notice them when wooshing back down! – sadly neither activity is suitable for most. Nearby is a generally undisturbed calcicole (lime-loving) flora. Between the slide bedding plane and the gorge is a seemingly man-made upstanding wall. This natural feature has a lot of interesting geology, but this can only seen close up and therefore outside the scope of this itinerary.

k: At the top of the slope near a telegraph pole (a left over from a wartime barrage balloon) one can perhaps just make out that the wall between the slide and the gorge ends in a sheer vertical drop. I came across this upstanding wall of rock some time ago and polishing a small sample discovered a fascinating texture. Some oolite grains are halved and offset but it is not clear if this is by micro tectonics or solution. A very similar upstanding vertical wall occurs just south of the peregrine viewing area near the circular walk. Although essentially a hardened rib of limestone cause mineralisation along a pair of major joint/fault the very unusual texture in this pink rock is as yet not fully understood.

l: Through or over a chain link wire fence from where the path is close to the edge, affords a good view of the bridge, its foundation rocks and gorge. Between here and the bridge the St Vincent's Rocks fault passes close to grilled off cave entrance. This fault is a major east - west orientated reverse fault which although similar to the much more significant Avon Thrust only thickens the sequence and does not repeat it as suggested elsewhere. The block you are standing on has been moved north and also up lifted up many meters so that almost the entire Avon Gorge the sequence is repeated. The only place this spectacular thrust fault can be seen is from the Portway as it passes Bridge Valley Road or from the west bank of the Avon. These are for another itinerary, but an effort should be made to drive past and hope the traffic lights are red, although the tow path cycle track along the whole of the Avon's east bank is wide flat and accessible.

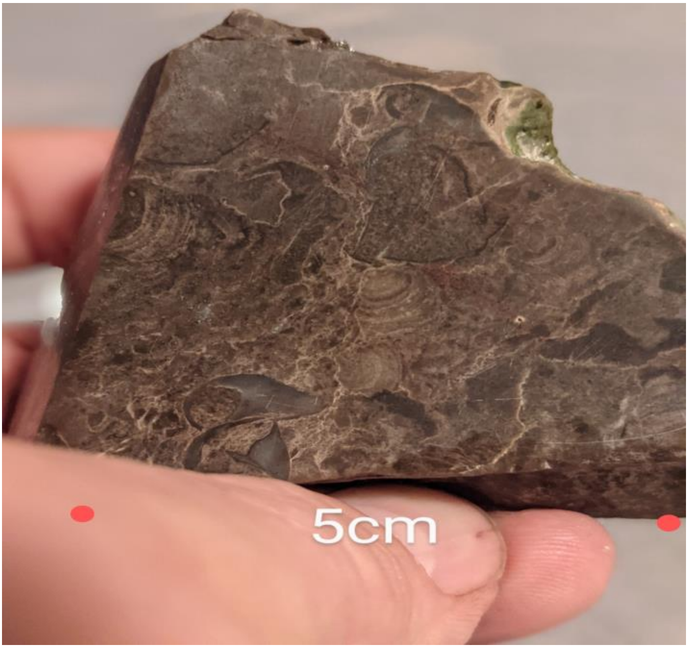
m: The Observatory. Probably the best place in the area to see fossils is to look in the building stones of the doorway of this historic building.

Return to the parking on Clifton Down Road using the tarmac path or descend back to locality ‘a’ however this path is very steep.

Rock Polishing

One of the biggest drawbacks to studying rocks is getting through weathered surfaces but there are many times when hammering is not permitted, and hammering often reveals little more information especially in limestones where fresh surfaces usually fracture across calcite cleavage. This may show some internal texture but more often hides it so that all we see is a crystalline sparkle. Thin sections are useful but these are expensive to obtain.

Acetate peels are an option for limestone where a polished surface can be etched with dilute acid and thin acetate film stuck onto the uneven surface with acetone. Once dry the plastic film can be peeled away and this provides a good substitute for a thin section. However, just simple polished surfaces can show up a lot of detail. Samples can be polished using wet or dry paper or better still proprietary diamond pads, and this simple cheap technique reveals a lot, such as here: -



Polished block from the quarry wall behind the playground:

Revealed are assorted irregular 'fragments', including nodules showing concentric growth lines and hook like sections (which are probably shell fragments), separated from the next by some matrix or more often by a thin winding sinuous line. These are stylolites where much limestone has been dissolved away by pressure solution and areas where a good deal of material has been lost resulting in 'clasts' seeming to be truncated or offset.

In conclusion

I hope you also agree that simple polishing exercise is extremely useful especially where no obvious texture can be seen. From this photograph the name Pseudo Breccia of the Concretionary Beds becomes clearer. The additional detail gained, especially from the rocks polished in the area near the bridge, show a very different texture to those from the Playground and it is now is beholden on the next generation to see how this simple inexpensive polishing method will aid future accurate mapping and correlation of rocks in this area and much further afield.

The exercise has proved that valuable field work can be done by a wheel-chair user, albeit with some help regarding the steeper paths. I trust the data base of accessible sites I have previously suggested become a reality soon and that efforts are also made to improve access at many other key geology sites.

All photographs and samples are by the author.