Farnham Geological Society

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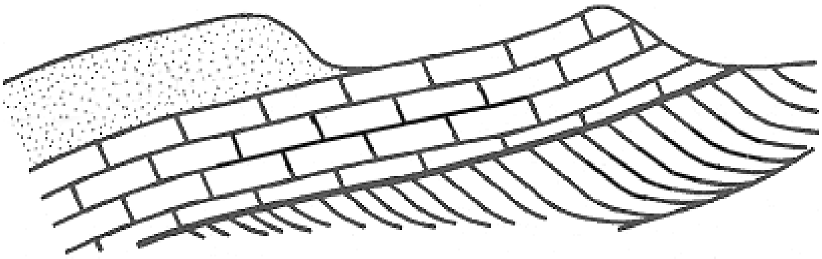

A local group within the GA

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Editorial

This edition of the newsletter includes snippets of geological / astronomical observations gleaned from one of the many scientific journals reaching our members and which they thought might be of interest to other members of the Society. This is considered to be preferable to just producing the summaries of the talks and field trips. I would be glad to get some feedback from members whether you like having these additional snippets.

My personal feeling is that it is important to provide good (even if long) summaries of our talks and field trips for those members who were unable to attend the events and to include plenty of diagrams, photographs etc. to assist in any explanations/enjoyment. I also feel that it is my job to provide a permanent record of what the Society has done as a true reflection of the Society for future reference.

Having said that, I also think it is a very good idea to provide members with additional snippets of relevant interest to most members, so feel free to send me any snippets which you have come across. Please provide me with full details of the origins of the articles and of their authors, so that I can give due recognition to their provenance and expertise.

Liz Aston

Field trip to The Isles of Mull, Staffa and Iona, 21-28 May, 2017

Led by Dr. Ian T. Williamson, reported by Liz Aston, Moira Jenkins

Snippets from the Mull Field Trips

We saw so much geology, all of it different, from the Precambrian to Pleistocene that it would be impossible to provide a realistic review of the trip, therefore I have chosen several features to concentrate on – things that are specific or iconic to Mull, Staffa and Iona.

Several of the geological terranes that comprise modern-day Scotland are represented on Mull (Figure 1); these include the Hebridean Terrane (Lewisian gneisses and (possibly) Torridonian strata), the Central Highlands or Grampian Terrane (Moine and Dalradian metamorphic rocks, Caledonian Granite), also Devonian lavas and strata, Mesozoic (Triassic to late-Cretaceous) strata and the remnants of an early Palaeogene volcanic complex. Glacial and post-glacial phenomena are also common and there are superb examples of many contemporary geomorphological features and processes. But we mainly went to see the Mull Central Igneous Complexes – just one of the many igneous complexes of this volcanic province.

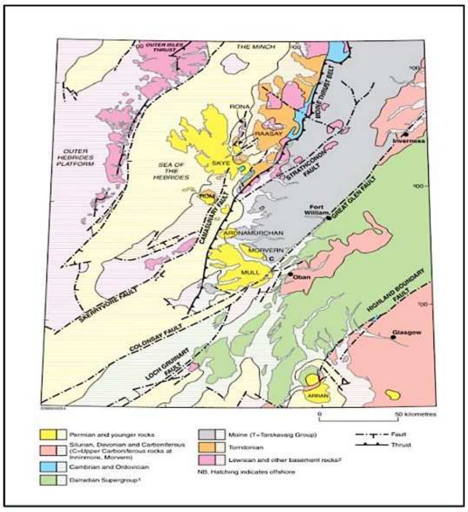


Fig.1: Major Units and Structural Features - Terranes

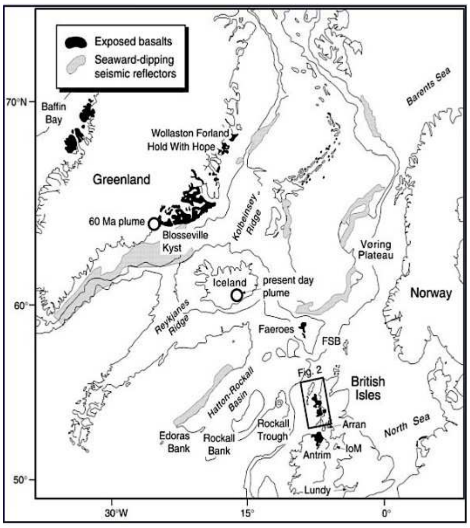


Fig. 2: The North Atlantic Igneous Province

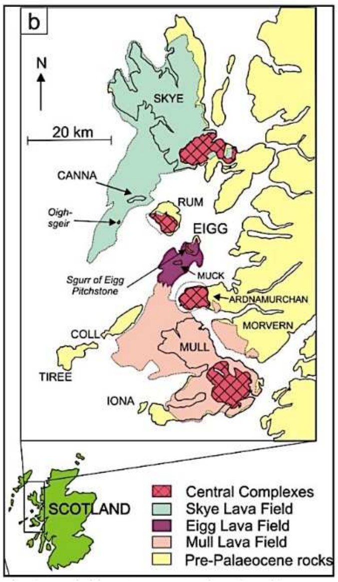
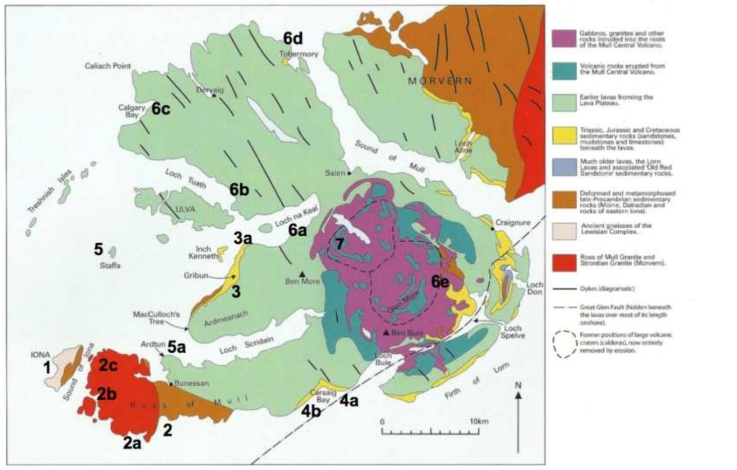


Fig. 3: Hebridean Igneous Province



Localities: 1-Iona: 2-Ardalanish Bay; 2a-Carraig Mhor; 2b-Sound of Eraid; 2c-Torr Mor: 3-Balmeanach & Gribun; 3a-Balmeanch Shore; 3b-Rubha Baile na h-Airde; 3c-Clachandhu: 4-Carsaig Bay; 4a-Carraig Mhor; 4b-Rubh a' Chromain: 5-Staffa; 5a-Ardtun: 6-Mull Circuit; 6a-Loch na Keal; 6b-Laggan Ulva; 6c-Calgary Bay; 6d-Tobermory; 6e-Glen More: 7-Beinn a' Ghraig.

Fig. 4: Central Mull complex (purple) and localities visited.

During the Palaeogene, the opening of the North Atlantic was accompanied by outpourings of basaltic magma from East Greenland to the W coast of Scotland (Figure 2) and southwards to the NE coast of N Ireland. This igneous suite is termed the North Atlantic Igneous Province, NAIP, of which Mull and its igneous rocks are an important part (Figures 3 and 4). One of the most famous images of volcanic rocks within the Mull area, is that of the iconic basaltic lava columns, which dominate the Island of Staffa, offshore, Mull, but there are many other equally iconic geologically if not visually as shown in the list below.

Volcanic Icons of Tertiary age - Staffa and Traps of the Mull Central Complex

The volcanic rocks of Mull vary in many forms from plutonic rocks to extrusive lavas, see Figure 4:

- Gabbros, which represent the 'hearts' of the intrusive centres on Mull: Centre 1 (Glen More), Centre 2 (Beinn Chaisgidle), Centre 3 (Loch Ba). Each had its own caldera, but the caldera location shifted to NW with time.
- Granite (Ross of Mull Granite) with its thermal aureole which impacted on the metamorphic rocks of the Moine Schists, changing the kyanite (high pressure form of Al_2SiO_5) to sillimanite (high temperature form) in the immediate vicinity of the granite. This is one of many granites, some of which are intimately associated with gabbroic intrusions within the central volcanic complexes.
- Sills – seen as sub-horizontal layers intruded amongst several of the lava outcrops; Loch Scridain Sill Complex.
- Ring dykes within the Central Mull Complex are present; they were seen from a distance but not examined in detail, see Figure 5 for model of formation.

- Dykes are common throughout the area, often in ‘swarms’, and of variable width, trending NW-SE and can extend for miles (probably to N Yorkshire).
- Cone sheets, also within the Central Mull Complex and again not examined in detail.
- Extrusive lavas: there are two main sequences of basaltic extrusives – the earlier Staffa Lava Formation, which is unconformable on earlier rocks, and the later Mull Plateau Lava Formation.
  - The famous columnar jointed basalts of Staffa form the basal most lava flows and the Formation extends onto Mull and was seen at several locations.
  - Basalt lavas as multiple thin sheets, stacked one on top of the other dominate the scenery around the Central Mull Complex, known as ‘traps’ as at Gleann Seilisdeir.

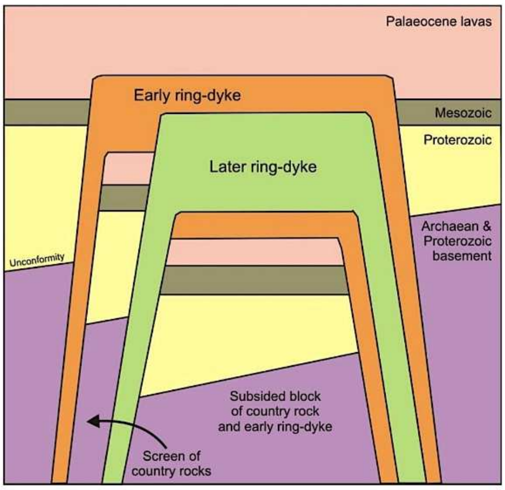


Fig. 5: Subsidence and ring-faulting Model for ring dykes

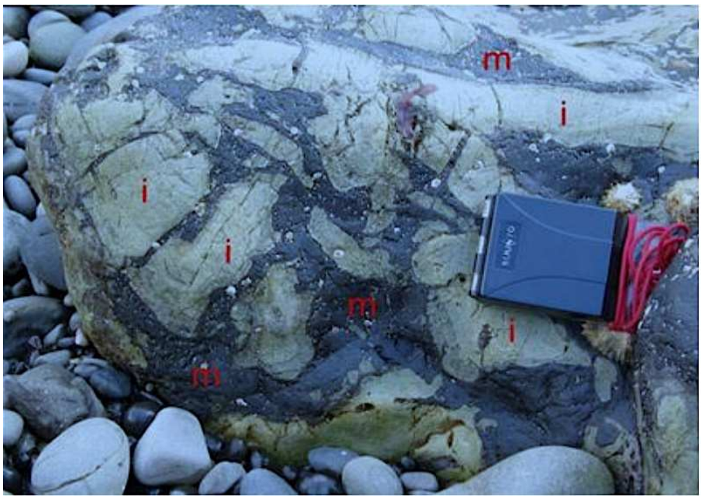


Fig. 6: Peperite, Carraig, Mhor, (m) unconsolidated dark silt- and clay-grade sediment intermingles with (i) basalt.

Fig. 7: Classic view of Staffa columnar jointed lavas.

Fig. 8: 2-tier columnar joint sets formed by the ponding of lava flows.

The Staffa Lava Formation is a complex, laterally variable sequence of lava facies, including the unusual peperites (Figure 6: dark mudstones with lava fragments, formed when magma extrudes into wet sediments). Although it is most famous for the exquisite columns seen on the Island of Staffa (Figure 7) there are other lithofacies and several ‘genetic’ sequences, each comprising a ‘basal’ sedimentary unit and an ‘upper’ volcanic unit, the following sequence being separated from the earlier one by a weathering or erosion surface. The thickness, distribution and lithofacies are controlled by existing Palaeogene faulted valley systems (or active, synvolcanic graben) and contemporaneous river systems. There is a close association of hyaloclastite breccias (breccias of hydrated volcanic glass formed by explosive eruptions under water) with the thick, two-tiered columnar joint sets formed by the ponding of lava flows (Figure 8).

Fig. 9: Basalt lava flows, ‘traps’, are piled into a terrace.

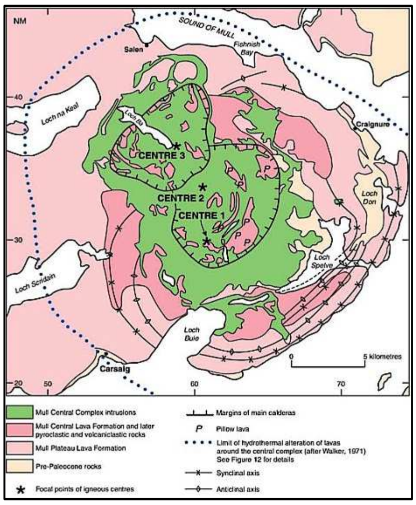


Fig. 10: Central Mull Volcanic Complex

The Plateau Lava Formation, which makes the majority of the island outside the central mountainous district extends to Morvern and Ardnamurchan. These basalts form a characteristic terraced (‘trap’) landscape (Figure 9). The lavas and earlier formations, are cut by a regional dyke swarm which probably represents the original feeding fissure system; there are also scattered plugs.

The Central Igneous Complex (Figure 10) is the exhumed and deeply eroded roots of the Mull Volcano. Large volumes of magma were emplaced into the upper continental crust and extruded out of 3 volcanic ‘centres’ in 3 different phases. Basic magma (basaltic) was dominant but the intrusions range from gabbros and dolerites to granites and granophyres, together with some hybrid intrusions. Many of the gabbros are layered intrusions due to long-term crystallization in static magma reservoirs, whilst the more evolved and hybrid types can occur as nested steep-sided stock-like bodies.

Arcuate, inclined intrusions known as ring-dykes of silicic composition have been intruded along steep outwardly dipping fractures resulting from the subsidence of a central, cylinder-like block (Figure 5) which may generate caldera formation at the surface.

Associated with the central complex are myriads of centrally-focused inclined sheet intrusions known as cone-sheets. The clear majority are basaltic or doleritic.

Iona Marble Quarry, Mull by Moira Jenkins

On our first full day on the field trip to Mull, we crossed to Iona and had a look first at rocks with sedimentary structures which were classified as Torridonian and may possibly be Dalradian. We crossed the line of the Great Glen Fault onto the Lewisian rocks which are more deformed and metamorphosed. We walked across moorland and peat bogs, looking for the Iona marble quarry, to which there is no obvious path. The vein of white marble, 6 to 8 m wide and Lewisian in age, is situated in a small inlet at the SE end of Iona. There is now a gully where the quarrying has removed the rock (Figure 11). This marble is a metasomatized, meta-limestone, white to yellow-cream in colour with greenish veining and mottling caused by the presence of varying amounts of tremolite and serpentinite. At the SE margin a yellow white quartzite can be seen (Figure 12).

Fig. 11: Gully in which Iona marble has been quarried.

Fig. 12: Yellow white quartzite seen at the SE margin.

The Iona marble may have been worked as early as 1745 and unsuccessfully later. The final attempt was in 1907 and it closed for the last time at the end of World War 1. The remote location was too hazardous for shipping out the marble. Today all that remains of the quarrying are the remains of a large winch and cable, a cutting frame, water tank, gas engine, wheeled platform and cut white stone blocks. These are listed as a Scheduled Ancient Monument.

Fig. 13: Dark Lewisian gneiss next to white Iona marble.

Fig. 14a: Machinery from former quarrying operations

Figure 13 shows the contrast between the pale marble and the dark Lewisian gneiss. The Lewisian is very finely cleaved and much sheared and perhaps represents a minor metasedimentary greywacke-turbidite-like sequence. Some of the old quarry machinery can be seen in the background of the photo. This machinery is better displayed in Figures 14a, b, c.

Iona Marble, which is highly ornamental, can still be seen in churches in S Scotland and was one of many marbles used to decorate Westminster Cathedral in London; examples also finding their way to churches in Jerusalem.

Fig. 14b: Machinery from former quarrying operations

Fig. 14c: Machinery from former quarrying operations

Fig. 15: Cut blocks of marble on the foreshore.

Fig. 16: Marble block

Good specimens of marble can be seen as boulders on the foreshore including cut blocks, which were never transported from the quarry (Figure 15) and as blocks with greenish mottling caused by the presence of varying amounts of tremolite and serpentinite (Figures 16, 17). Folding can also be seen in the limestones near the shore, described by Ian Williamson as rheomorphic folding (Figure 18).

Fig. 17: Greenish mottling due to presence of tremolite and serpentinite.

Fig. 18: Folding of limestone on foreshore

Ardtun Leaf Beds, Mull by Moira Jenkins

The Ardtun Leaf Beds are at an internationally important locality for early Palaeogene palaeobotany. They are in a steep gulley at Biod-an-Sgairbh, where beds of river and lacustrine deposits can be seen cropping out between Tertiary lavas of the Staffa Suite. The leaf beds were deposited in times when Mull's volcanoes were dormant and vegetation grew on the weathered lava flows about 60 Ma ago.

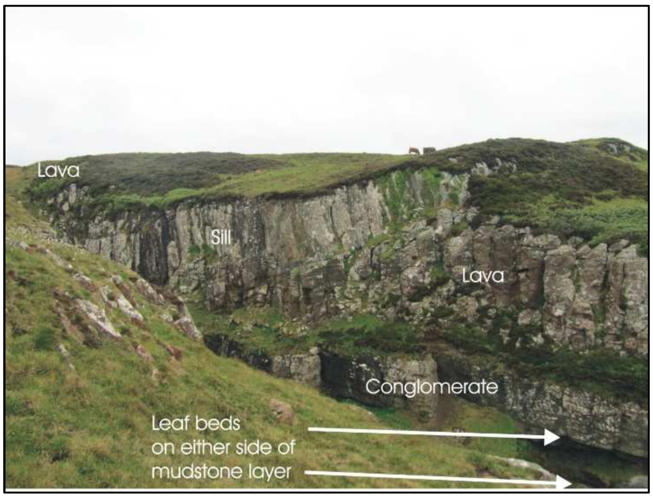


Fig. 19: View of upper part of the W side of the gulley.

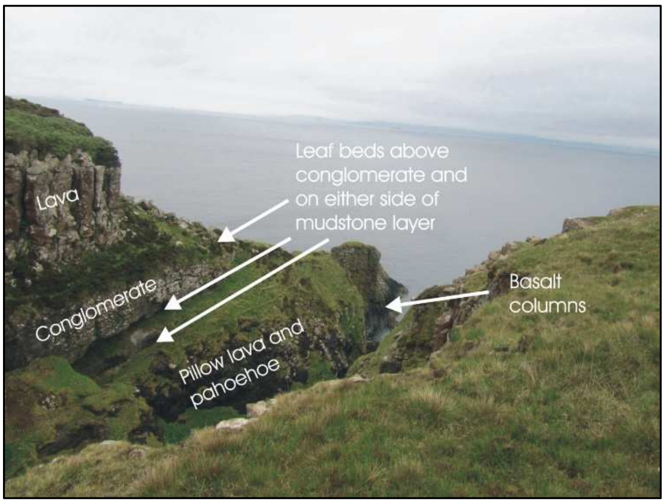


Fig. 20: View of lower part of the W side of the gulley.

Figure 19 shows the west side of the gully at the S end. The upper lava flow can be seen to be intruded by a prismatically jointed dolerite sill, which cuts across the layers of lava. Below the lava flow is a conglomerate layer, at the base of which are clasts of flint and silicified Chalk pebbles as well as pebbles of igneous rock. In Figure 20, to the north of the previous figure, nearer the sea, the conglomerate layer can be seen again with lava, which erupted after a brief quiet phase, at the top of the picture.

The three leaf beds are found above the conglomerate and on either side of the layer of mudstone and fine-grained siltstone, which lies below the conglomerate. In these leaf beds, carbonized fossil tree leaves of plane, hazel, oak, and gingko (maidenhair) have been found. These are believed to have been washed into a lake or deposited in river channels in a marshy area. The fossils found suggest a warm, moist and temperate climate. Other finds include pollen from conifers and ferns with fragments of insects. The leaf beds show in Figure 20 as clefts eroded by geologists' hammers. Many more trees have been identified from fossil pollen. The underlying lava contains pillows and was erupted into a shallow lake. The lowest leaf bed is underlain by a thin coal seam, which passes down into a thin, whitish concretionary root clay on top of the lower basalt flow. Further down the gully at sea level is the Staffa

Lava Formation columnar basalt. A basalt filled lava tube can be seen in the cliff on the eastern side whilst hexagonal / polygonal basalt columns are well shown in these cliffs and on the sea stack.

We did not visit the famous MacCulloch's Tree, a coniferous tree trunk, which is on the Ardmeanach Peninsula which we could see across the bay. This has been preserved in its position of growth despite having been totally engulfed by a lava flow. The location is remote and requires a long walk.

We all appreciated the enormous effort which Ian Williamson had put into the whole trip and I thank him for allowing me to use many of his photographs to enhance the introduction.

Discovering the source of the River Wandle

Summary of talk given by David Gill, Research Officer, SE Rivers Trust, Sutton

This research project (Heritage Lottery Funded (HLF)) started in August 2016 and ended 12 months later. The River Wandle is located in the London Boroughs of Croydon, Merton, Sutton and Wandsworth. It passes through several towns, which from source to mouth are: Croydon, Carshalton, Hackbridge, Mill Green, Ravensbury, Morden Hall Park, Merton Abbey Mills, Earlsfield and Wandsworth. It has tributaries of the River Graveney and Norbury Brook and its sources are from Wandle Park and Waddon Ponds, West Croydon and it flows into the River Thames.

The river is 14km long and reaches a maximum elevation of 35m. The mean discharge at Connelly's Mill, Ravensbury is 1.70 m^3/s, with a maximum of 39.3 m^3/s and a minimum of 0.22 m^3/s. At Beddington Park, Croydon, the mean discharge is just 0.18 m^3/s.

The Wandle is a Chalk stream with a natural source of water derived from the Chalk of the North Downs. There are less than 240 Chalk streams left in the UK. Chalk streams like the Wandle are a globally-rare and precious part of our cultural heritage, but many now suffer from human modification and other pressures including over-abstraction of water, sources of pollution including roads and sewage treatment works, and the spread of industry and urban areas.

The majority of the Wandle flows north through urban areas of South London. The presentation focused on the geology of the Wandle catchment areas. The bedrock map (Figure 2) of the catchment shows two distinct parts to the Wandle catchment:

1. The S part of the catchment area is dominated by Chalk forming the North Downs, mainly rolling hills and dry valleys reaching a height of around 180m above sea level.
2. The N part of the catchment area is dominated by London Clay, forming flatter land. This second part of the catchment is covered in superficial deposits of periglacial and fluvial origin from an older and larger Wandle. These sands and gravels are dominated by poorly sorted, semi-rounded flints derived from the Chalk.

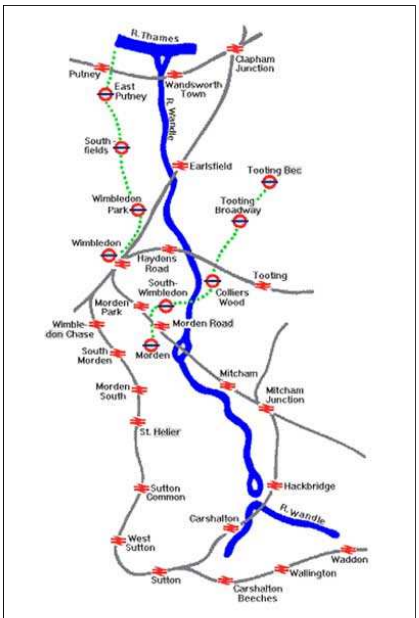


Fig. 1: Map of the River Wandle (not to scale)

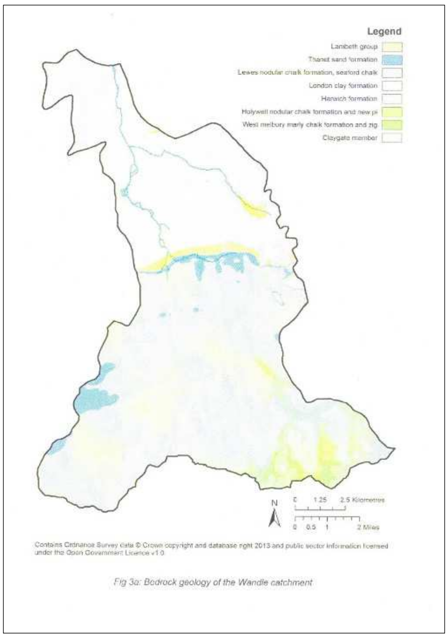


Fig. 2: S catchment dominated by Chalk (N Downs).
N catchment dominated by London Clay.

Fossil evidence from the sands and gravels of the N catchment area suggested they were deposited during the Late Pleistocene when the climate was much colder than it is today. Beetle fragments of species presently found only in N Scandinavia provide a climatic guide to conditions in the Wandle catchment at the time. Mammoth remains suggest likewise.

It has been suggested that during this relatively colder period of time, some 100,000 years ago, the ground was frozen. When precipitation hit the Chalk hills to the south the resulting runoff was unable to infiltrate the frozen soil and flowed across the ground surface carrying flint and other materials with it. On occasions flooding (mainly due to spring thaw) will have carried these materials through the Chalk valleys and down in to the clay areas below (to the north). As a result we find outwash fans marking where these flooding events happened along the old (proto-) Wandle.

Today the climate has warmed and the soils on the Chalk are no longer frozen. These soils now allow rainwater to infiltrate through them to create a hidden water table beneath the ground. However occasionally the rainfall is sufficient across the North Downs to raise the water table to the surface and flooding will occur along the valley floors (ephemeral streams like this are termed bournes). This last happened in the winter of 2014 when transport and communications to the area south of Croydon were severely disrupted for nearly three months. Historically these floods were known locally as the ‘Woe Waters’ and it was said they were forbearers of bad news – these bournes were said to occur once every seven years!

Research by Peake was based around tracing the former routes of the proto-Wandle from the North Downs into the old River Thames (which at the time flowed through what is now the town of St. Albans). Peake aged the superficial deposits of this early river and proposed that it has shifted since the Ice Age.

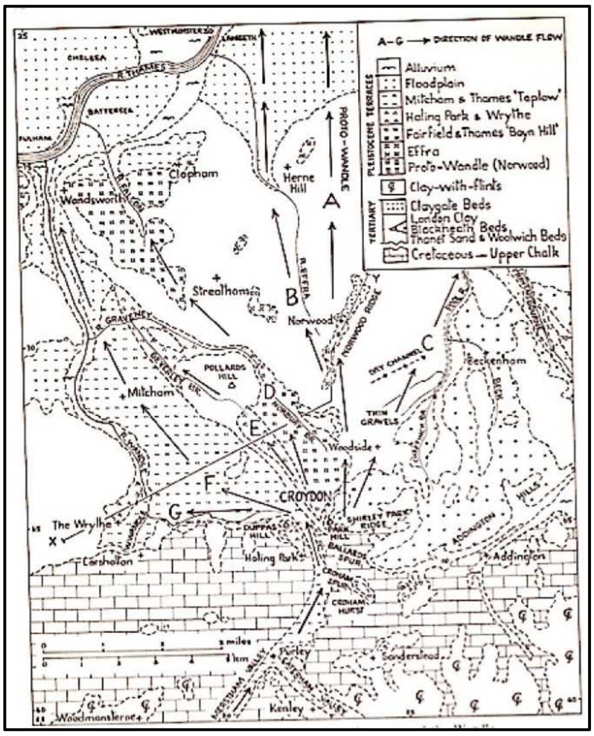


Fig. 3: Map of Proto-Wandle and the changes in course.


Fig. 4: Above Carshalton Water Tower 1996;
Below same view in 2016

The map above (Figure 3) suggests how the proto-Wandle has been diverted over time (from A to the present day G). As a result the N half of the Wandle catchment is dominated by river terraces. Attempts by Peake and others have failed to correlate the terraces of the Thames (Boyn Hill and Taplow terraces) with that of the River Wandle. Further research is required.

The presentation ended with an understanding that the sources of the River Wandle continue to change. People continue to abstract water from the Chalk aquifer under the North Downs – as a result the water table has dropped and even in recent times the sources have continued to shift. One example in Carshalton shows the impact of the abstraction of water on a local lake (which feeds the Wandle) and shown in Figure 4, the change from lake in 1996 to infilled and now grassed field in 2016.

The source of the River Wandle is influenced by the bedrock geology, climatic events now and in the distant past and actions of people today. What this will mean for the river in the future remains uncertain…

References:

Peake, D.S., 1983, The Ground under Croydon, Croydon Natural History and Scientific Society

Wandle Trust, 2012, Catchment Plan for the River Wandle
http://www.wandletrust.org/wp-content/uploads/2014/10/WCP_Section_3_Wandle_Catchment_Characteristics.pdf

Building Stones of Farnham: Walk led by Dr. Diana Smith of the Open University

Reported by Sally Pritchard, FGS Member

It was a balmy summer evening when twenty-two enthusiastic FGS members met at the Maltings for a walk examining building rocks of Farnham. The walk was led by Dr. Diana Smith, who started by illustrating the historic mapping of the area. The first example showed the Weald, a plunging anticline, looking like a dog. In those days geology stopped at the coast and started again in France. Advances in mapping were, and still are today, thanks to oil industry surveying. She supplied handouts on brick bonding and limestone classification and discussed mortar versus cement. Cement being impermeable creates damp problems when used incorrectly for instance with sandstone. Anatomy of a brick: long side = stretcher: short end = header: frog = the indentation on the underside, designed to hold bonding material.

Diana demanded we work out what materials from the Weald would have been used for Farnham buildings. We decided Chalk, Bargate Beds, flint, ironstone - Folkestone Formation, sandstone, malmstone and Gault Clay, which has the rare virtue of being frost-proof when fired. Farnham vernacular is brick. We compared the different quality of brick on the front as opposed to the less visible side of a building and noted the high status, non-structural, herringbone formation used in a timber-framed construction in place of the usual wattle and daub. The Romans used herringbone patterning too.

In the Churchyard, to the tones of the practicing choir inside, we examined the building stones. Bath Stone, an oolitic limestone and Portland Stone, the latter viewing under magnification, contained mica and black specks of glauconite (very low weathering and very friable) an indicator of marine sediment. It is a status rock of the area. There were also Sarsens and Malmstone blocks as well as patches of freshwater Purbeck 'Marble'.

Working our way round the Church tower Diana despaired of the poor restoration work, the mixture of mortar and cement work and the damage it was causing, the unsympathetic replacement of building stone and window surround, some in red - a job lot from Devon, perhaps?

As rock dries out, salts come to the surface creating case hardening. When this is broken, as with engraving on tombstones, dampness gets behind the protective hardening, raises it and hence destroys it over time. Diana insisted we stop to pay homage at the tomb of William Cobbett. Leaving the church we passed over a naturally non-slip paving stone (?Yorkstone - the sandstone had a 'primary current lineation' on multiple quartz cemented very fine layers; each layer may partially wear off, leaving a rough, non-slip surface). These are used to pave London streets. Passing through an alleyway we noted wall rocks exhibiting holes where they had formed around plant roots now long gone.

In the high street marbles and granites were discussed - more talk of permeable and impermeable rocks and natural DPC's. Builders, it seems, use the terms granite and marble incorrectly. We saw polished imported Larvikite and Precambrian granite from Scandinavia. We viewed an old drain pipe embossed with hops - Farnham hops were the most expensive in England apparently! Diana lamented the loss of rocks behind modern shop fronts.

And thus, with a picnic outside the Maltings, ended a most interesting and informative, albeit exhausting, tour of Farnham's building stones. Most enjoyable.

Geological information from the MH370 search area in the SE Indian Ocean

Summary from: Kornei, K. (2017), Seafloor data from lost airliner search are publicly released, Published on 21 July 2017. © 2017.

https://eos.org/project-updates/geological-insights-from-malaysia-airlines-flight-mh370-search

The uncertain fate of Malaysia Airlines flight MH370 prompted a major geophysical search effort of the SE Indian Ocean from June 2014-2016. Aircraft debris found in the W Indian Ocean suggests the aircraft entered the ocean in this search area and the result is detailed maps of the ocean bed topography and sedimentary profiles over a 75x160 km area, trending NE-SW, centred on Broken Ridge (Figure 1). Deep canyons and landslides can be seen but no wreckage of flight MH370.

The MH370 search area is roughly 2000km off the W coast of Perth, Australia (Figure 1) where water depth was typically >5000m and locally >6000m. The data which have been released are shown below and include videos with 3-D tours through some areas. See *Fly-through of Broken Ridge and Diamantina Trench from © Commonwealth of Australia (Geoscience Australia) 2017 on YouTube*.

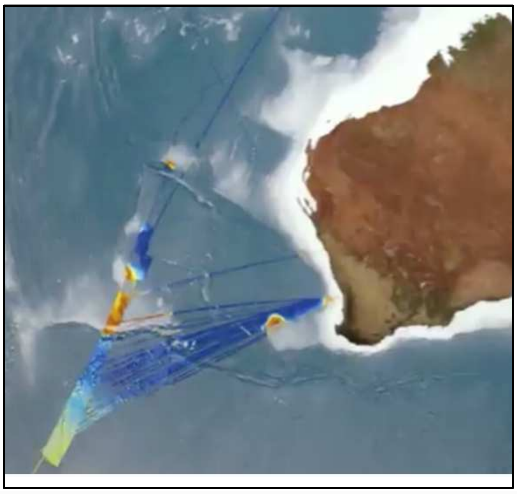


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Fig. 1: Search Area – Yellow Browns are Higher Elevations, Blues are Deeper Areas.

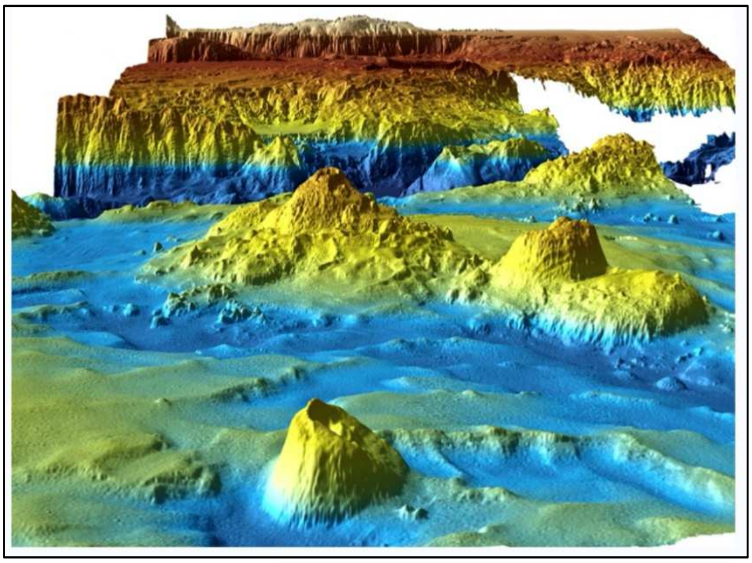

Fig. 2: Relief Models of the Diamantina Escarpment, looking NW (upslope). The seamount in foreground is ~1.5km high. In the middle & background, the escarpment and trough mark the N margin of the rift. Vertical exaggeration is x3. Credit: Kim Picard and Jonah Sullivan.

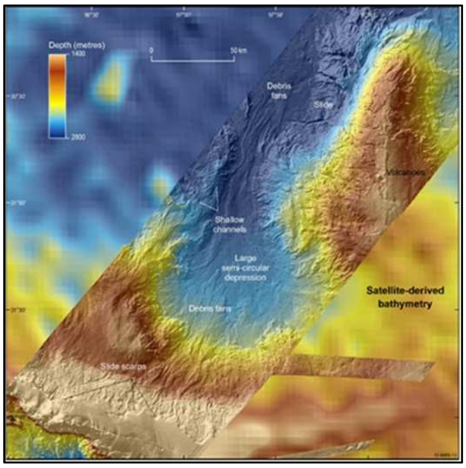

Fig. 3: A large depression on N flank of Broken Ridge show numerous debris flows and slides.

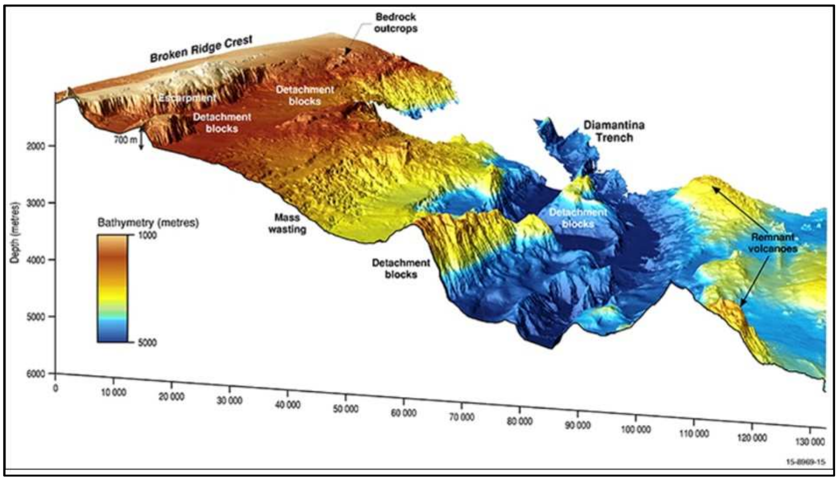

Fig. 4: A 3-D model looking E of the rifted S flank of Broken Ridge (N part of the rift valley) along the Diamantina Escarpment.

The results show that the Indian Ocean seabed comprises normal oceanic crust (not related to hot spots), submarine plateaux, ridges, seamounts, sea knolls, and microcontinents; in other places, seafloor spreading, flood and hot spot lavas and tectonic structures are present.

The Diamantina Escarpment, the S flank of Broken Ridge, plunges from its crest at 638m down into a trough bottoming out at 5800m (Figure 2). This rifted flank includes escarpments rising more than 1000 m above the ocean floor, slopes as steep as 67°, and fault blocks about 12 x 25 km in size and rising more than 1200 m above their base (Figure 4). Large-scale ocean floor features include escarpments (as much as 1200m high), detachment blocks, grabens, and areas of planar floor within the trench, which is up to 10km wide. Bedrock is exposed in places at the top, on the flank and down to depths of ~1350m. Also exposed are igneous basement rocks, pre-rift sedimentary sequences, and overlying sedimentary sequences, which accumulated on the ocean floor syn- and post-rifting. WSW–ENE lineations on some scarps probably represent exposed steeply dipping bedding planes.

The N flank of Broken Ridge shows slides and debris flows that crosscut and run out as debris fans into the large semi-circular depression (Figure 3). A large depression, ~90km diameter, with ~500m of relief, lies ~70km NE of the crest of Broken Ridge. Crosscutting slides and debris flows dissect the flanks of the depression, recording episodes of sediment flow, with slide scarps as much as 180m high and 10km wide and debris fans more than 150km long (Figure 3). In other places, slides and debris flows have reworked sediment downslope.

A rifting model is used which suggests that faults developed parallel to the axis of spreading with elongated blocks of crustal material, grabens step down into a deep trough with spreading ridge volcanics.

Quartz crystals – left or right handed?

Figure 1 shows typical quartz crystals and identifies the mixture of faces on those crystals – these different faces are termed m-, r-, s-, x- and z- faces.

The s-faces are tinted blue and the x-faces are tinted orange on both the left-handed and right-handed quartz crystals above. It can be seen that their position relative to the r-, z-, and m-faces can change and does change on these two crystals shown. It is this relationship to the r-, z- and m-faces that determines whether the quartz is left- or right- handed – see below:

- If an x- or s-face is present at the **left side of an r-face**, the quartz is called left-handed

- If an x- or s-face is present at the **right side of an r-face**, the quartz is called right-handed

This difference is caused by different atomic structures within the quartz crystals as outlined above in Figure 2; i.e. it depends on the spiralling downward silicon atoms – those spiralling downward in a counter-clockwise are left-handed whilst those spiralling downward in a clockwise direction are right-handed.

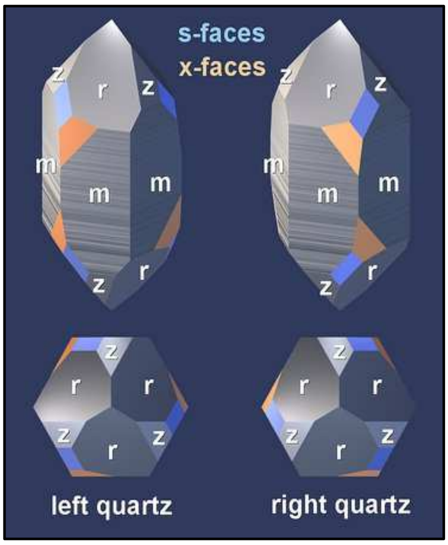

Fig. 1: Crystal Faces on Left- and Right-handed Quartz Crystals

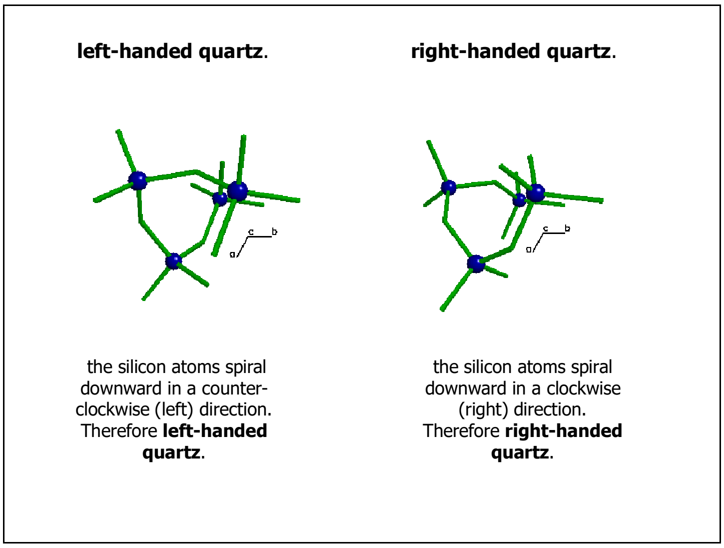

Fig. 2: Different Atomic Structures Associated with Left-handed and Right-Handed Quartz Crystals.

John Stanley, Member of FGS

Interesting and useful websites:

- The Geological Society have a virtual library – I am not sure if it is accessible to all – but hope all can access some if not all of it - https://www.geolsoc.org.uk/virtuallibrary.

- US Geological Survey In Cooperation with the Geological Society of America have a website with a great deal of information about the geology and maps of the U.S.A. – namely *Database of the Geologic Map of North America—Adapted from the Map by J.C. Reed, Jr. and others (2005)* https://pubs.usgs.gov/ds/424/ By Christopher P. Garrity and David R. Soller, 2009.

How wide is a micron?

One micron equals one millionth of one metre and is identified as ***1µm.*** In order to grasp the size of such a small particle, some comparisons are made below using a human hair as a handy starting point.

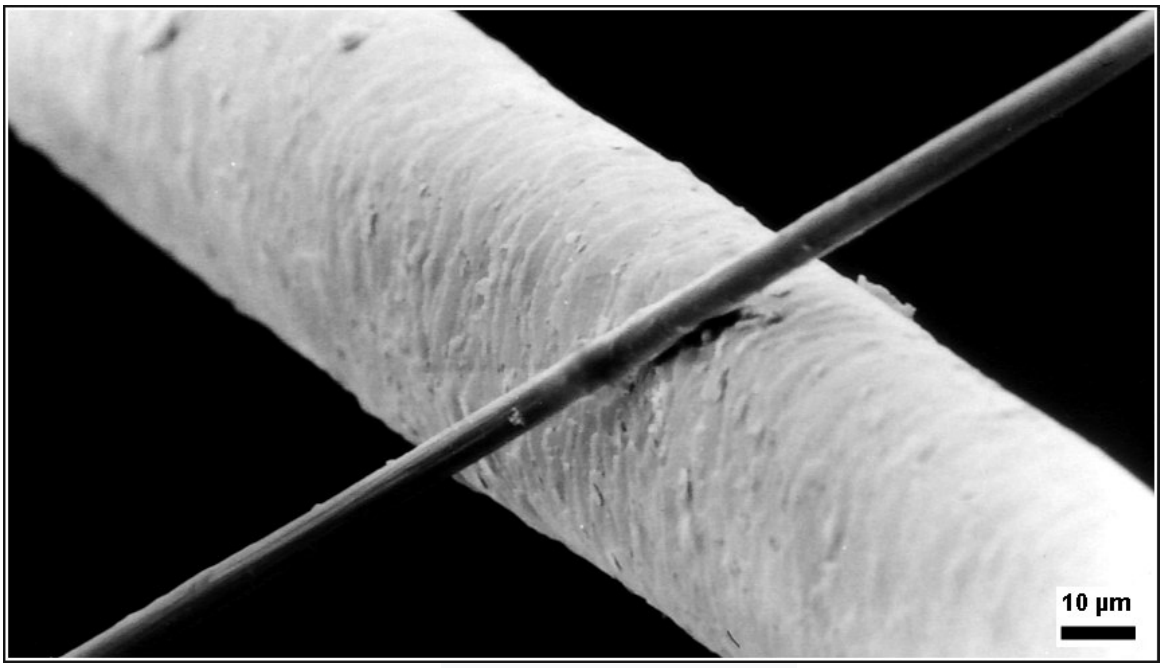

Fig. 1: A 6µm diameter carbon filament,
compared to a 50µm diameter human hair.

Figure 1 shows a 6µm diameter carbon filament, compared to a 50µm diameter human hair. Other common sizes are described below:

Between 1µm and 10µm:

- 1–10µm – length of a typical bacterium;
- 3–8µm – width of strand of spider web silk;
- 5µm – length of a typical human spermatozoon's head;
- ca. 10µm – size of a fog, mist or cloud water droplet;
- 10µm – size of fungal hyphae (long, branching filaments).

Between 10µm and 100µm

- 10 to 55µm – width of wool fibre
- 17 to 181µm – diameter of human hair
- 70 to 180µm – thickness of paper

So one micron really is very small!

John Stanley, Member of FGS