Ledbury Naturalists Field Survey 2017 - Dales Hall

Appendix 1 Geology Report

Most of the ridge of the Malvern Hills is composed of the Precambrian Malverns Complex, intrusive igneous rock which crystallised out from molten magma deep in the Earth's crust. These rocks, shown as MvC in purple on the map, have been dated as about 677 million years old. However, on Hangman's Hill, Broad Down and Tinker's Hill, there is rock, which formed when lava erupted from volcanoes in an island arc. These Precambrian volcanic rocks of the Warren House Formation, WHF shown in green on the geology map below, have been dated as having formed 566 million years ago.

The major fault line, the East Malvern Fault, runs along the base of the steep eastern edge of the hills. By Dales Hall it is behind, west of, the field known as the Wonderment. On the geology map below, Dales Hall is near the top right, SE of Hangman's Hill, next to the downthrown tick mark on the dashed black line of the East Malvern Fault.

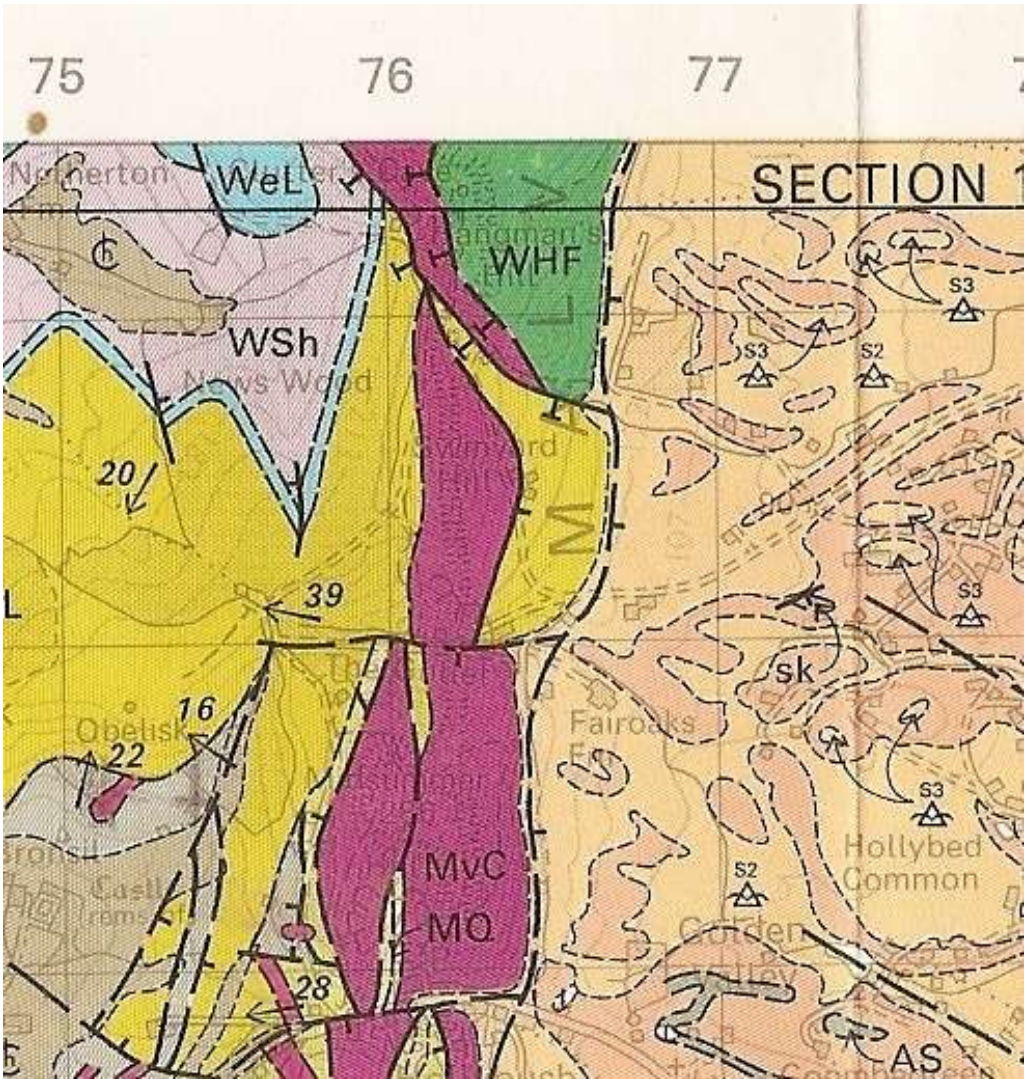


Fig 1 Geology map copied from BGS 1:50,000 Tewkesbury Sheet 216.

The movement on the fault has pushed up the Precambrian rocks, that form the ridge of the Malvern Hills. The downthrown side of the fault is the Severn Valley underlain in the Dales Hall area by Triassic Mercia Mudstone Formation, shown as orange on the map. The total movement on the fault, which took place in a series of phases, is 2.5 kilometres (2,500 metres).

Shown on the map as paler orange, overlying the mudstone are remnants of river terrace deposits of the River Severn, - terraces 2 and 3. Near to the hills, these are in fact, 'head' which is material which was produced during the Ice Age. The ridge of the Malvern Hills was a nunatak, which means that bare rock rose above the ice in the valley below. The rock of the hills was frost shattered during the intense period of cold, when water penetrated into cracks and these were opened up as the water froze. The loosened rock fragments have moved down the slope sluiced by melt waters and were spread over the area of permanently frozen ground in the area of the adjacent lower land. These gravels, made up of angular fragments, coat Castlemorton Common and are the reason that there are only very thin soils which are not suitable for agriculture.

The photo below shows examples of two types of volcanic rocks from the Warren House Formation which have moved down the hillside. 566 million years ago volcanoes were erupting in an island arc, either on land or under the sea. The darker rocks contain more iron and magnesium minerals. Many lavas when they erupted contained air bubbles or vesicles. At a later stage, these vesicles have been filled by green epidote crystals, which can be seen as round green shapes in the rock and there is also a green vein of epidote.

Fig 2 Spilitic basalt (rich in sodium from the sea water) containing epidote crystals which have grown into air bubbles in the lava.

Fig 3 The rhyolitic lava in the photo above is paler in colour.

This lava was much richer in silica and was stickier in composition leading to more explosive eruptions from the volcanoes. Iron minerals show up as red streaks. When both of these rocks types are exposed on the surface, they are weathered, giving the iron minerals a generally rusty red colour.

At Dales Hall the gravels form scree composed of enormous rock fragments. These can be seen in a quarry in the woodland just below Dales Hall, where large angular rocks are set in a finer matrix. Large quantities of shattered blocks of the volcanic rock have moved down the hillside in the intense cold of the Ice Age when this area was exposed above the ice which

moved down the valley below. This periglacial scree is mainly composed of large angular rock fragments with very little fine material. Examination of the rock shows that it is local material derived from Broad Down and Hangman's Hill, which are composed of the volcanic Warren House Formation. These are seen in the photo to the left. The fragments are mainly coarse with the largest being many tens of centimetres across.

Fig 4 Angular rock fragments seen in the pit below the house

The rock fragments are volcanic rock of the Precambrian Warren House Formation. The 'head ' forms the ridges running perpendicular to the hills.

There is a deep valley, Doles Hole, which was probably eroded by melt water, between two ridges of the periglacial scree.

Fig 5 Steep sided valley of Doles Hole

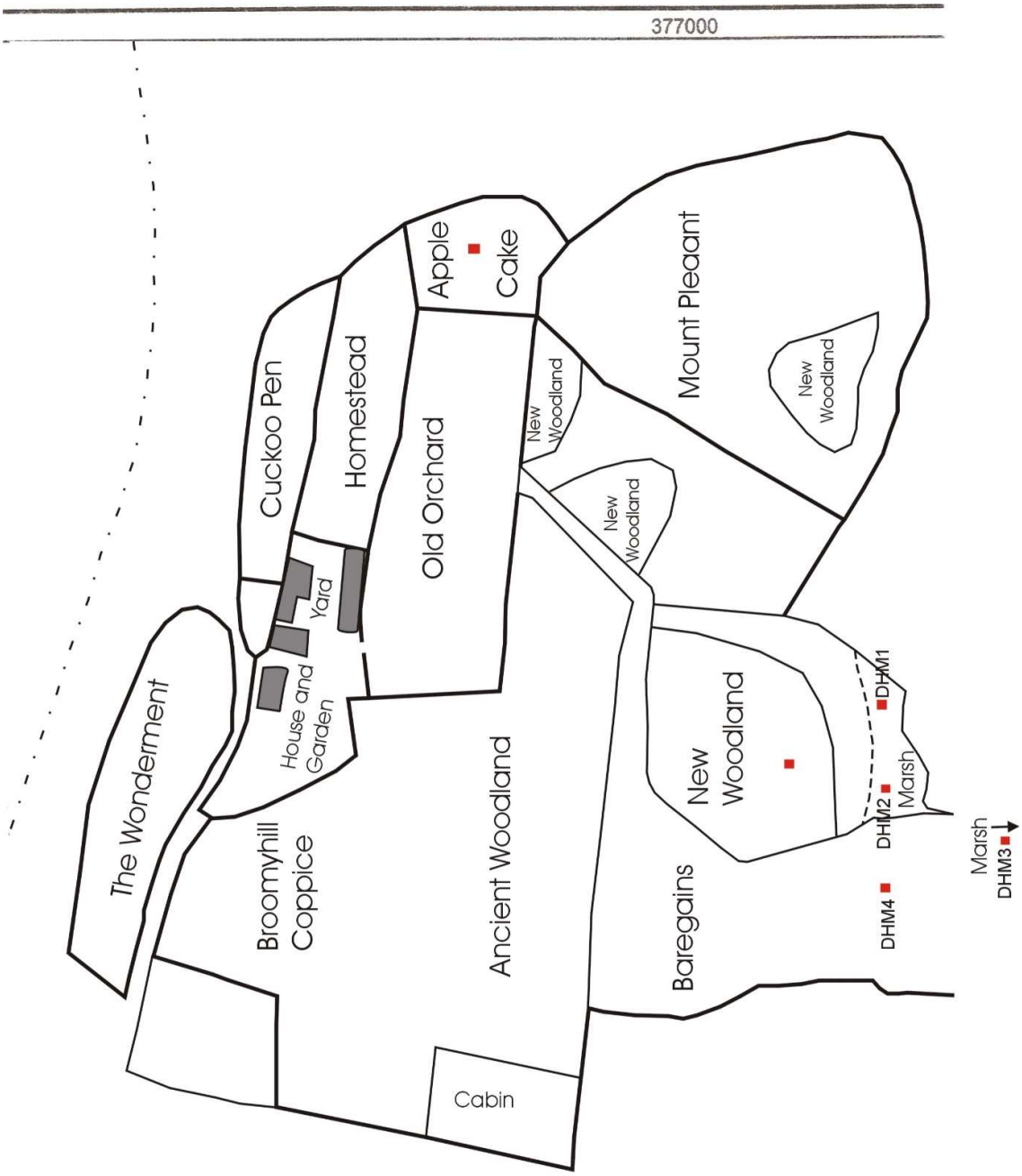
Another ridge of the same scree of volcanic rock fragments was uncovered in a trench dug in the field, Applecake, by Tim Cameron in 2005. See photo below taken on 2nd November 2005.

Fig 6 Trench dug in the field Applecake

In 2005 Tim Cameron used his digger to dig trenches on his property at Dales Hall to reveal the nature of the underlying rock. As well as Applecake, one was dug on Baregains, 2 in the adjacent marshy area and one by the pond at the bottom end of Baregains.

The plan below shows the location of the trenches which are described later.

The dotted and dashed line on the plan is a line of electricity wires and pylons, which, just here, roughly marks the line of the East Malvern Fault. Underlying the hills above it are the Precambian igneous rocks and to the east, below it, are the Triassic mudstones covered in places by gravels.



Dales Hall Plan showing positions of trenches

Fig 7

Adjacent to Baregains is a marshy area. The photographs below show the marshy area with its moisture loving vegetation and the mature trees behind it on the right hand side, as it was in 2005 compared with the present day, when many alder saplings have grown in front of the older trees.

To the left is a photo of the marsh in 2005 with the wet area extending into the field Baregains.

Fig 8 Marsh in 2005

Fig 9 Marsh in 2017 Alder trees have grown over half the area of the former marsh. The grass in the former marshy area does not appear to be different from that in Baregains field.

To the left is a photo of the 'marsh' in 2017, when the ground has been dried by extraction of water by the tree roots of the alder saplings. The surface of the rest is much drier and the plant cover is very different from 2005.

The trenching programme in 2005

In 2005, as well as the trench in Applecake, further trenches were dug. (See the plan, Figure 7 for locations.) These were in the marshy area, trenches DHM1, DHM2 and DHM3, and also a trench DHM4 in Baregains.

In trench DHM1, under 18cms of soil, there was a great depth of pale clay with, at some horizons, angular fragments of the volcanic Warren House Formation. These clasts varied from gravel to boulders in size. The clay was very well sorted in the layers with the angular rocks. The base of this pale clay had not been reached at 102cms. Here the digging ceased because the digger was becoming unstable.

Fig 11 Pale clay, dug from trench DHM1, towards the northwest end of the marshy area.

The photo to the left shows the trench DHM1 dug in the marshy area into a thick accumulation of pale clay. **Fig 12 Trench DHM1 dug to 102cms deep into the pale clay.**

Below is a photo of the trench DHM2 showing a deep deposit of clay with pale streaks which have been gleyed and adjacent areas from which have not had all of the iron minerals washed out and which still have a rusty red colour of material, which has come down the slopes of the hills.

Trench DHM 2, was dug to 170cms and again the bottom of the clay was not reached but the water table was hit. Clay has been washed in and ponded. It has mixed with the red slope deposits. The water table has fluctuated. During the Ice Age, the clay was sorted by being washed into depressions, where the water was very still and even frozen.

Fig 13 Trench DHM 2

To the left is a photo taken in 2005 looking towards the bottom of Baregains to an adjacent marshy area with a pond at the bottom of the field. Here the trench DHM3 was dug.

Fig 14 Looking down Baregains to the pond

Fig 15 Trench DHM3 dug into pale clay in a very wet area near the pond.

A further trench DHM3 was dug by the pond at the bottom of Baregains field to a depth of 112cms under soil of 20cm thickness. The clay is pale because it contained little or no organic material, as nothing was able to grow in the cold conditions of the Ice Age, when the clay was deposited. In the wet conditions of the marsh, it has been gleyed, and all the iron minerals have been washed out to settle at a greater depth. It is postulated that the fine material of the clay settled and was sorted in a cold sheltered area but occasionally there was rapid run off from the hills bringing down coarse angular material.

A trench on the ridge in Baregains, DHM4, went into Mercia Mudstone at a depth of 160cms.

Fig 16 Digging the trench DHM4 on the ridge of Baregains

Fig 17 Trench DHM4 went into orange clay and silt, of coarser material than that found in the marsh. The trench was dug to 165cms depth. The soil layer was about 16cms thick. Triassic Mercia Mudstone was reached at a depth of 160cms. The vertical smear of pale clay shown in the photo was on the digger blade from the digging of the previous trench at DMH3. Mercia Mudstone was laid down about 225 million years ago on a desert plain when this area was on a large arid landmass in the northern desert belt at about the latitude of the present-day Sahara Desert. The red colour of the rock is given by the oxides of iron which formed in the arid environment. The Mercian Mudstone is only rarely exposed because it is easily eroded and covered with vegetation.

The trench in Baregains has paler greenish areas where the iron oxide minerals have been reduced to ferrous hydroxides of iron.

More of the pale clay has been found by Fir Tree Cottage, during the digging of a well. However, augering, on a marshy area on Castlemorton Common itself by the track to Dales Hall Farm, went into red soil. There are only certain areas in which the conditions were suitable for the accumulation of great thicknesses of the pale clay.

A small hole was dug in the wooded area above the marsh and this went straight into Triassic Mercia Mudstone Formation under a thin layer of soil.

Analysis of the clays was carried out and detailed in the report of an independent study which has yet to be published:-

Hollis, D.B. and Payne M.J - The Origin of Clays from the Malvern Hills, Worcestershire 2015.

This states that at Dales Hall the white clay is shown to be heavily weathered basalt. It is evidently redeposited from 'runoff' from the nearby outcrop of the Warren House Formation, which is of volcanic origin. It is a 'swelling smectite', similar in structure to a bentonite.

Dales Hall has a very interesting geological history stretching back almost 700 million years. The area has been at the edge of tectonic plates for much of its history, being subjected to numerous earth movements, which have pushed up the Malvern Hills. Later there was stretching / extension of the Earth's Crust and a rift valley was formed in the Severn Valley in which much younger rocks were formed in the Triassic Period. In much more recent times the area was affected by the intense cold of the Ice Age.