This is an example of one of our educational worksheets providing site specific information

For more information contact us through the website: www.bucksgeology.org.uk

Whiteleaf Information Sheet

Geology of Whiteleaf Hill, Princes Risborough - geological notes

Site statistics

Grid reference: SU 8215 0370.
Ordnance Survey map: Aylesbury and Leighton Buzzard Sheet 165.
Geological maps: 1:50 000 series *Thame* sheet 237; and *Aylesbury* sheet 238.
Bucks County Council administration area: Wycombe District (site code:80H11)
Owned by: Bucks County Council; managed by The Chilterns Countryside Management Project.

Area of site: 27 acres

Access, location and parking: From the A4010 at Monks Risborough take the road signed "Whiteleaf". Park in the Whiteleaf Hill Car Park, next to the Ridgeway access point. This is a large car park, suitable for groups using cars (coach access prohibited by low bar at entrance).

Introduction

The site lies within Green Belt and within the Chilterns area of Outstanding Natural Beauty. It makes a prominent feature on this part of the Chiltern's escarpment above the town of Princes Risborough . The geology is primarily one of Chalk (Cretaceous in age) overlain by Clay-with-flints (Tertiary). There are exposures in the Middle and Upper Chalk*, with occasional finds of fossiliferous flints. The site also displays a number of geomorphological features. From the viewpoint the control of geology on landscape can be seen and within a very short distance from the site the outcrop areas of Lower Cretaceous and Jurassic strata can be reached. In general the area is divided into the clay lowland of the Aylesbury Vale and the Chalk escarpment. The latter is dissected by numerous dry valleys. The clay vale is dissected by the modern river courses, and it is interrupted by a mid-vale ridge of harder, topographically higher outliers. Together with the ecological and archaeological interest of Whiteleaf, this site makes a very interesting visit.

* The terminology of "Lower, Middle and Upper" Chalk is now redundant, but appears in many maps and textbooks. The new terminology is as follows:

Group	Subgroup	Formation	Member	Old Classification
Chalk Group	White Chalk Subgroup	Lewes Nodular Chalk Formation	Top Rock Member Chalk Rock Member at base	Upper Chalk
		New Pit Chalk Formation		Middle Chalk
		Holywell Nodular Chalk Formation	Melbourn Rock Member at base	
	Grey Chalk Subgroup	Zig Zag Chalk Formation	Totternhoe Stone Member at base	Lower Chalk
		West Melbury Marly Chalk Formation	Cambridge Greensand Member at base	

This is an example of one of our educational worksheets providing site specific information

For more information contact us through the website: www.bucksgeology.org.uk

Geology of the area

The rocks outcropping in the area beneath the escarpment, in the Aylesbury Vale, range from the Jurassic to the lower Cretaceous (150 to 95 million years in age). The rocks of the escarpment range from Upper Cretaceous to earliest Tertiary (95 to *c.* 55 million years). The Upper Cretaceous is represented by the Chalk (Lower, Middle and Upper) and the Tertiary is only represented by patchy distributions of Clay-with-flints. Deposits such as tufa and river gravels belong to the Quaternary (the Ice Age) and the Holocene.

Older rocks have been proved at depth by boreholes. The oldest rocks penetrated by these boreholes are **Cambrian to Ordovician** age marine mudstones. There are also Lower Palaeozoic volcaniclastic rocks at depth in the region immediately west of Brill, together with probable **Silurian** lavas and tuffs to the south of the area. The mudstones formed part of the Iapetus Ocean - an enormous ocean at least 4,000 km wide which separated Scotland from England from the Cambrian to Ordovician periods. As subduction gradually consumed this ocean the result was a massive outpouring of lavas and violent eruptions of ash and pyroclastics. These are readily seen in Scotland , the Lake District and Wales , but also lie at depth beneath the Whiteleaf area. When the Iapetus Ocean crust had been consumed by subduction the result was continent collision as the crust containing Scotland collided with England , and the subsequent Caledonian orogeny produced folding and uplift of the crust.

Devonian and **Carboniferous** sediments were deposited in the area, but the preceding and then subsequent uplift of the Variscan orogeny produced erosion and hence a limited distribution of these strata at depth. This gap was further enhanced by a prolonged period of erosion during the **Permian** to **Triassic** periods when Britain was within the northern desert belt.

The following Mesozoic era was dominated by deposition under marine conditions, interspersed by regressions and substantial periods of erosion. Directly overlaying the eroded Palaeozoic platform are Jurassic sediments of the **Lias**. The Lias (Toarcian in age, *c*. 190 Ma) consists of limestones and muds deposited in a shallow, tropical sea which deepened over time. Ammonites were prolific in this ocean. This strata does not outcrop in the area of Whiteleaf, but can be seen in numerous small exposures in north Bucks. Overlying the Lias, also not seen at outcrop in the area, but lying some 400 m beneath Whiteleaf is the **Great Oolite** (Bathonian to earliest Callovian in age *c*. 170 Ma). This is a collective name for a number of beds of limestones and clays, predominantly known for its oolitic limestones which outcrop to the west of Whiteleaf in the Oxford area and Cotswolds. They vary laterally, but all represent warm, shallow seas and lagoons or shoreline muds.

The following sequence from 170 to 150 Ma is to be found at outcrop in the Vale of Aylesbury lying beneath Whiteleaf. However, exposures are rare and often temporary. The sequence of the **Cornbrash** to the **Kellaways Beds** and **Oxford Clay** to **Ampthill** and **Kimmeridge Clays** represents deepening seas. The evidence for this is seen in the rubbly, wave-torn Cornbrash limestones (shallow marine) to the progressively offshore muds of the Oxford and Amphill clay sequences. The sandy beds of the Kellaways Sands, the West Walton Beds and the late Kimmeridge fine sands indicate periods when terrestrial influences and energy levels increased (i.e. a shallowing of the sea). These sediments are only very rarely exposed, but form the bulk of the low ground of the Vale of Aylesbury, spreading out beneath the viewpoint at Whiteleaf.

Also visible from the viewpoint is the topographic expression (the hills of the mid-vale) of the harder beds which make up the next part of the geological succession: the **Portland** and **Purbeck Beds** and **Whitchurch Sands**. These are 150-145 Ma and 140 Ma, respectively. The Portland and Purbeck sequence reveals the evidence that shallow-water conditions prevailed in the later part of the Jurassic period. The Portland Beds are the most northerly extent of this famous oolitic and fossiliferous limestone, best known for the Dorset exposures from which it gets its name. The Bucks variety of Portland Stone is distinguishable from the Dorset type by having a poorer cement (more crumbly), a darker colour (often beige/pale brown in contrast to the paler cream-beige of the Dorset rock) and also being more fossiliferous (in general). The Portland Stone was often used as a building stone in areas of Bucks close to the outcrop area (e.g. Stone, Hartwell, Quainton, Princes Risborough and Aylesbury, amongst many others). Repairs are now carried out using Dorset Portland Stone, as all Buckinghamshire quarries exploiting this material have long since closed. This rock, together with the overlying Whitchurch Sandstone, are the prime reason for the “mid-vale ridge” as they provide harder caps to the tops of these hills. The rest of these deposits have been eroded away leaving the hills of Brill, Ashendon, Waddesdon, Hartwell and Stone as topographically higher remnants (outliers) surrounded by the older clays of the vale.

The **Whitchurch Sandstone** is best seen in the buildings and walls of Brill, although it commonly occurs as building blocks in other villages in the area. It is distinctive due to its red-brown colour, but should not be confused with the iron-cemented Lower Greensand (outcropping at Brickhill), but also sometimes used in buildings within the vale. This period of time is an enigmatic one for Bucks. The Whitchurch Sands are our only evidence of large rivers which criss-crossed an uplifted landscape. The evidence for the Bucks environment of the end-Jurassic and early Cretaceous is missing, as 40 million years of history are eroded away during this time. The following period (the Lower Cretaceous, *c.* 115 Ma) is represented sparsely by the **Lower Greensand** locally. These sands and occasional sandstone deposits outcrop as the Greensand Ridge in the Brickhill area, but form no exposures in the area of Whiteleaf. There are small outcrops present at Aston Sandford, Ford and Bishopstone which are composed of a coarse, iron-stained, pebbly sand. However, the lithology can only be inferred by a subtle change in soil, not by exposures. The Lower Greensand represents a period when the sea returned to the area, which broke through as a narrow seaway from Norfolk to the Isle of Wight . From this period onwards the sea-level continued to rise as the world experienced the largest global warming in its entire history. The overlying **Gault** (*c*. 110 Ma), at first just a shallow sea, gradually deepened to form a sequence of offshore muds. The clays contain phosphate nodule bands with a prolific collection of fossils. It becomes more calcareous towards the top - heralding the advance of the **Lower Chalk** (*c*. 95 Ma).

The Gault forms the low ground immediately adjacent to the Whiteleaf escarpment, from Longwick to Aston Stanford, and forming a belt 5 km in width parallel to the escarpment. There are a few outliers of Gault, notably at Chilton and Long Crendon, where the Gault Clays cap the top of the hills.

The break in slope at Monks Risborough (from c. 90 m to 100-110 m) is entirely due to the **Upper Greensand** outcrop overlying the Gault. This rock is the shoreline equivalent of the Gault and is composed of a calcareous sandstone and siltstone. The Upper Greensand is harder and therefore produces a topographic “bump”, a ledge which follows the contours of the land surface the far side of the towns of Monks and Princes Risborough (away from the escarpment). There is also a line of springs at this level (the water penetrates the porous sandstone, but the impermeable clays of the Gault beneath prevents further draining downwards towards the water table. The water thus appears at the surface as a spring line marking this junction.

The majority of Monks Risborough and Princes Risborough lies on the pale grey, chalky clays of the **Lower Chalk**. The ground surface begins to rise gently across the Lower Chalk outcrop from just over 100 m to *c.* 120 m. The **Melbourne Rock** is a hard bed which forms another notable ledge on the topography at the foot of the escarpment and marks the boundary of **Lower** and **Middle Chalk** and lies in the fields beneath just before the housing areas of the town. There is a second line of springs at this junction - marking the more porous Melbourne Rock with the clay-rich and more impermeable Lower Chalk. The Upper Icknield Way path crosses over the Melbourne Rock which can sometimes be recognised in the worn footpath at SP 818 040.

The steepest incline of the Chalk escarpment, which rapidly increases to *c.* 200 m, is formed by the Middle Chalk. The uppermost 10 m of the Middle Chalk is visible in the bare parts of the slopes at Whiteleaf below the Whiteleaf Cross (SP 822 040). This uppermost section can be seen to contain some flints (but not as numerous as the Upper Chalk).

The **Chalk Rock** has been a common building stone in the past (often called “Clunch” by the Victorians) and is a harder bed marking the boundary between the Middle and **Upper Chalk**. This can be seen in the small quarry exposure close to the road. The Chalk Rock is a hardground which often contains numerous *Thalassinoides* burrows and represents several periods of breaks in sedimentation of the normal Chalk lithology.

Both the Middle and Upper Chalk are well-cemented, pure white limestones. The differences lie in the thin and occasional marl bands in the Middle Chalk and the distinctive bands of flint within the well-bedded Upper Chalk. The Middle Chalk can be best seen in the small quarry reached from a pathway running from the Whiteleaf car park (adjacent to the road). The Upper Chalk makes up the remaining 50 m of the topmost escarpment slope along parts of this hillside.

This is an example of one of our educational worksheets providing site specific information

For more information contact us through the website: www.bucksgeology.org.uk

At the end of the Mesozoic period further earth movements (the Laramide) again resulted in this area becoming a landmass. During this period there was no doubt the deposition of Palaeogene sediments which are seen in adjacent areas (e.g. the palaeosols of the Reading Beds at Chesham to the east of Whiteleaf, or to the south at Denham and Reading). However, at Whiteleaf, no evidence of this period remains - having been removed by intense weathering and erosion.

The deposit lying directly on the topmost Chalk is **Clay-with-flints**. This is a residual deposit formed from deep weathering of the Chalk. The Clay-with-flints has a patchy distribution which follows the topmost escarpment and dip-slope, but it is dissected and removed along numerous dry valleys. Clay-with-flints is usually a reddish-brown clay containing lots of angular flints (up to 50% flints). Sometimes it is a yellow clay or a reddish-brown clayey sand. Whatever its overall appearance it is a Chalk solution residue which is often added to by illuvial clay from the overlying Tertiary or Quaternary deposits.

The dry valley systems were cut during the Ice Age. Although these valleys are dry today, they were once the site of torrential flow from melt waters of a retreating ice sheet and melting snow. They are common features throughout the Chalk escarpments of southern England , not just the Chilterns. The majority show the typical form of a water-cut valley - fairly steep sides, an asymmetry in form and an overall v-shaped profile. Today water does not flow over the Chalk outcrop as chalk is normally a highly porous rock. Numerous fractures and pore spaces ensure water permeates through the rock very efficiently to the water table. However, under tundra conditions the water in pores and fractures becomes frozen and water is forced to flow over the surface. In this way, deep river channels can be cut down relatively rapidly. As soon as the climate ameliorated, permanent frozen ground thaws, and the normal drainage system and porous nature of the Chalk is resumed.

There are also deposits within dry valleys, for instance, the **Princes Risborough Sand and Gravel**, which were deposited by a southeasterly flowing river - an ancestral River Wye (after the dry valleys were cut). This river ceased to flow when the tributaries leading to the ancestral Thame developed and created a different drainage system. The deposit is rich in chalk and flint pebbles and lies in a very restricted area on the escarpment known as the Princes Risborough Gap. This deposit (and others like it at the bottom of dry valleys) comprises sands and gravels that are rich in chalk and flint. At the surface this deposit is always decalcified to form a reddish-brown, sandy loam with abundant flint pebbles (angular and rounded).

Till is found to the northwest of Aylesbury and proves that the Anglian ice sheet extended to, and beyond, the Chilterns. It consists of a brown, pebbly clay where the pebbles are both local (mainly flints, small Chalk pebbles and reworked Kimmeridge clay) as well as from further afield (quartzite and 'Bunter' quartz pebbles).

The area of **peat** present southeast of Longwick is due to the waterlogged ground forming as a result of spring seepage from the base of the Upper Greensand. This is the line that a number of small springs occur along the base of the escarpment at Whiteleaf. These are a direct result of water catchment through the permeable Chalk and Upper Greensand. The water passes downwards until it reaches the impermeable clays of the Gault and will then run along the top surface of the Gault to emerge at a spring line.

Erosion continues to the present-day. In human terms, this process is almost imperceptible. Geologically it is the normal rate of erosion which can plane down Himalayan-sized mountains in 10 million years, just a snippet of geological time! Evidence of soil erosion is seen as minor landslip and soil creep all over the site, but especially at the escarpment edge and slope. Where erosion is rapid there is poorer vegetation cover and chalk debris forms and moves gradually down-slope. The present site management is aimed at containing the weathering and erosion processes by enhancing the stabilising effects of the Chalk grassland and by maintaining the woodland at a more appropriate position back from the escarpment.