The Yorkshire Wolds: geology and landscape

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At the present time the superficial features of the Wolds landscape are entirely man made. Since the Neolithic the land has been deforested, grazed, cultivated and quarried and its water supply exploited. However the underlying landforms which consist of slopes are entirely natural. Any landscape is dependent on the underlying geology which in most areas of similar size to the Wolds would comprise a number of rock types. The rock type controls the rate of its erosion Those rocks which are more resistant to erosion would form hills and those most easily eroded would form valleys. The Wolds however are made of one rock type, chalk. Chalk is white, pure, and monomineralic being made entirely of calcite: so you could say that the Wolds are made of calcite. The Chalk Formation does contain relatively small amounts, probably less than 5% overall, of non-chalk components. The most obvious of these are the hard siliceous concretions, generally referred to as flints, and centimetre-thin layers of marl.

During the 30 million years of the second half of the Cretaceous Period there was a major sea level rise and up to several hundred metres of chalk were deposited over large areas of northwest Europe and elsewhere. At the end of the Cretaceous the seas withdrew and Britain became uplifted in the west where vast outpourings of basaltic lava initiated the opening of the North Atlantic Ocean. Below the North Sea the crust was stretched and continued to sink and so Britain was tilted generally towards the east. During the subsequent 60 million years of the "Tertiary" period northern England continued to be progressively tilted and remained a land area from which most of the Chalk was completely eroded under a warm temperate climate, leaving a small remaining area of Chalk in the southeast, the Wolds.

The land surface would have been covered with deciduous woodland probably dominated by Ash and Oak beneath which a humus-rich soil would supply CO_2 to the infiltrating rain. The resulting acidified water would dissolve the calcite and flush it eventually into the North Sea. On the Wolds several hundred meters of chalk were thus removed by chemical weathering and solution at a rate of about 5m per million years leaving only a thin residue of flint and marl. This resulted in a lowering of the land surface creating an eastward sloping plateau pockmarked with solution pipes and broader hollows (dolines). Along the western and northern margins of the plateau the slow solution of the Chalk contrasted with the more rapid erosion rates of the underlying clays and created a steep Chalk escarpment

A major feature of the northern Wolds is the Great Wold Valley running eastwards from the present watershed at Wharram Le Street. This valley, now generally dry, differs from all the other dry valleys on the Wolds in its greater breadth, more gently sloping sides and lower longitudinal gradient. It was probably eroded at some time during the Tertiary by a major river flowing from the west in a similar manner to valleys eroded through the chalk downs of the Weald in southern England by rivers such as the Mole and the Arun.

Throughout the Tertiary the climate remained fairly uniform becoming drier and cooler for the last fifteen million years or so. But then major and geologically rapid climatic changes became the hallmark of the succeeding Quaternary Period. A series if ice advances from the north brought periods of intense cold to northern Britain. During at least one of these glacial periods ice overtopped the Wolds but had little erosive effect apart from the removal of the superficial clay with flints lying on the plateau. It did leave a telltale scatter of erratics from northern England and Scotland. Glacial erosion of the Vale of York resulted in the capture of west flowing rivers by the ancestor of the Ouse and left the Great Wold Valley high and dry.

.For the other cold periods the details of the position and nature of the ice front is known only from the last glaciation when an ice free area comprising the Wolds, the Vale of Pickering and the North Yorkshire Moors was almost entirely surrounded by ice sheets. Under these conditions there can be no doubt that the ice free area was under permafrost. Permafrost would have totally changed the nature of weathering and erosion of the chalk. Direct evidence of permafrost on the Wolds is now limited but a resistivity survey of a hectare on Sancton Wold carried out by ERAS clearly shows a pattern of ice wedge cracks and what appears to be a collapsed pingo. A pingo is a small rounded hill formed by the progressive growth of an ice lens below it. When eventually the ice melts the pingo collapses.

The chalk and its flint nodules were disintegrated mechanically by ice crystal growth and freeze and thaw into angular gravel exposed on the surface due to the lack of vegetation and soil. Strong winds from the cold surrounding ice transported fine silt (loess) over the surface of the Wolds. Precipitation for most of the year was in the form of snow which would have been windblown off the exposed areas of the plateau into the dolines.
During the summer months the top 60cm or so of the surface would thaw but permafrost below this would keep the resulting water near the surface. The summer sun would have been quite powerful since, in contrast to the arctic, the Wolds lie at the lower latitude of 55^0N. Water from snowmelt could rapidly fill dolines and drain them through the lowest point on the doline rim rapidly cutting steep-sided valleys through chalk gravel. Such water courses would have flashy inconsistent flows and form a braided pattern carrying a bedload of chalk and flint gravel. Such gravelly braided streams are characterised by flat floored valleys with longitudinal gravel bars bordered by a sharp break in slope. Their longitudinal gradient is relatively steep. All these features are characteristic of the most obvious features of the Wolds, the present dry valleys. Their steep sides have a pretty consistent angle of 21^0 which is about the angle of rest for chalk gravel. The angular chalk gravel transported as bedload rapidly became rounded by abrasion by the harder flint and was deposited in the lower courses of the valley systems
Each successive cold period would rejuvenate and extend these valley systems. In the intervening warm interglacial periods chalk erosion would revert to very slow chemical solution below woodland cover and the valleys would be fossilised as dry valleys. Since the last period of permafrost occurred only recently, around 20,000 years ago, it is not surprising that the dry valleys we see today, the hallmark of the Wolds scenery. look so fresh and youthful.

Summer drainage off the Wolds and off the ice was not be able to flow into the sea as it was dammed by the coastal ice front. It flowed generally in a south southwesterly direction parallel to the ice front cutting through the lowest points on the eastward trending interfluves between the valleys, leaving curvilinear ice marginal channels. These are best preserved south of North Dalton. The water eventually egressed via the Goodmanham Gap into the southern part of the Vale of York which was occupied by Lake Humber.

When the ice sheets enclosing Yorkshire finally retreated about 15,000 years ago the permafrost began to thaw and the top several metres of the land became saturated with water. The lack of vegetation to bind the surface layer encouraged mass movement down the steeper slopes on the escarpment, the sides of the Great Wold Valley, and the steep sides of the dry valleys, The numerous landslips are the youngest part of the present landscape. They are developed all along the Wolds escarpment and are particularly well seen on Birdsall Brow. Large slides transported enough rock to form small hills standing below the escarpment. A fine example is seen at Staple Howe, the site of an early iron age settlement. Stack Hills along the base of the escarpment on the south side of the Winteringham Gap are deep rotation slides where large masses of Chalk have slid down along a curved fracture and thus rotated so that the originally flat top of the slide now dips at up to 70^0 towards the escarpment. Large lobate flows are characteristic of the more eastern parts of the Great Wold Valley and some dry valleys are partly blocked by landsides as at Vessey Hill and in Deep Dale on Bishop Burton Wold.

The post-glacial amelioration of the climate allowed the return of woodland once more which survived for a few millennia before Neolithic man began to deforest and cultivate the land. This process has continued to the present day and has obscured the solution features of the Wolds plateau but exposed the now grass-covered dry valleys so characteristic of the Wolds landscape.

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