Wind Gaps, and the Contrast Between Scarp and Dip Streams

A wind gap is a depression or col marking where the course of an ancient river valley crossed the line of an escarpment or upland ridge. Uplift of the escarpment or ridge, and disappearance of the river, through capture or beheading, means that the gap becomes dry (i.e. only the wind blows through it). There are a number of wind gaps along the length of the Cotswold escarpment: Fig. 1 shows the locations of those of the North Cotswolds: note that all of the wind gaps occur at re-entrants in the line of the Cotswolds escarpment, and lie on the watershed separating Thames from Avon/Severn drainage.

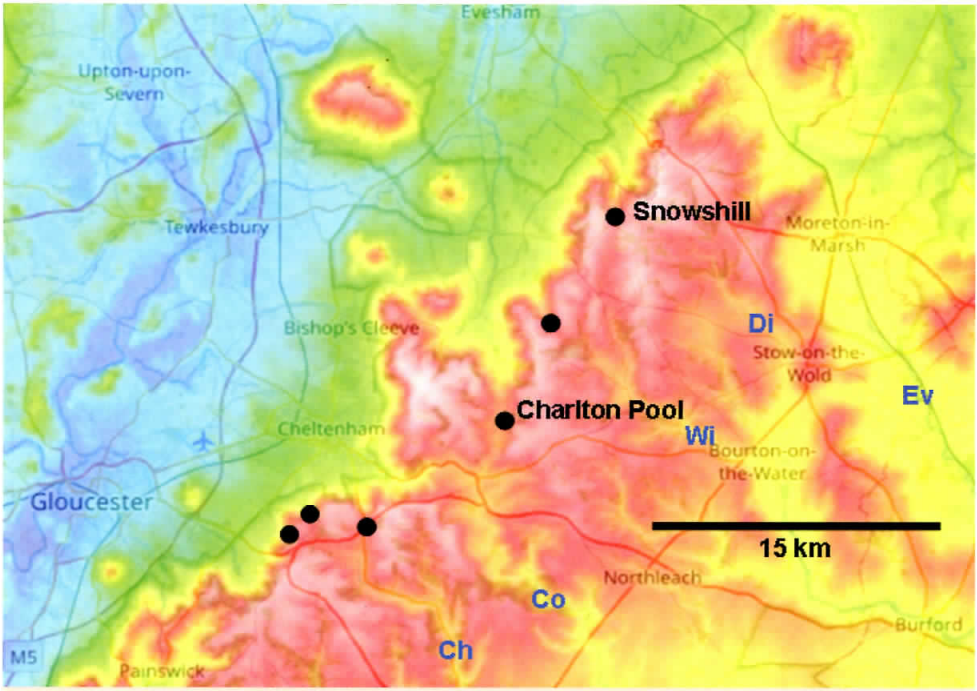

Fig. 1. Location map of the North Cotswolds. The black circles show the location of some of the best developed wind gaps in the escarpment. Those discussed in the text are named. The colour fill represents ground elevation above OD. Key to rivers: Ev = Evenlode; Di = Dikler; Wi = Windrush; Co = Coln; Ch = Churn.

Geomorphology is the study of landforms – their origin, evolution, and the processes which shape them. I hope that this series of articles on the geomorphology of the North Cotswolds will assist a wider appreciation of the landscape of the High Wolds, how it came to evolve, and its possible impact on the fauna and flora of the area.

The Cotswolds have never been glaciated: the closest that the ice came was during the Anglian ice advance (~450,000 years ago) when the ice reached as far south as a line approximating the present-day Cotswold escarpment. However, the Cotswolds did suffer severe periglacial

(tundra) conditions during each of the many ice advances of the last 2.6 million years (i.e. the Quaternary period) and these, coupled with the intervening interglacial periods, during which temperatures approached those of the present day, have had a profound effect on the Cotswolds landscape. In addition, these marked climatic variations have resulted in great changes through time of the fauna and flora which colonised and, in many cases, departed this landscape. These changes in climate, and the landscape which they shaped, can provide clues to the variation and distribution of the Cotswolds' present-day fauna and flora.

As described in my first article (Jeans, 2020), the basic plan of the present-day Cotswolds drainage system was carved out before the Anglian Glaciation by major rivers flowing from Mid-North Wales and the English Midlands southeastwards towards the ancestral Thames and thence into the North Sea, with little or no Cotswolds escarpment to hinder their flow (Fig. 2).

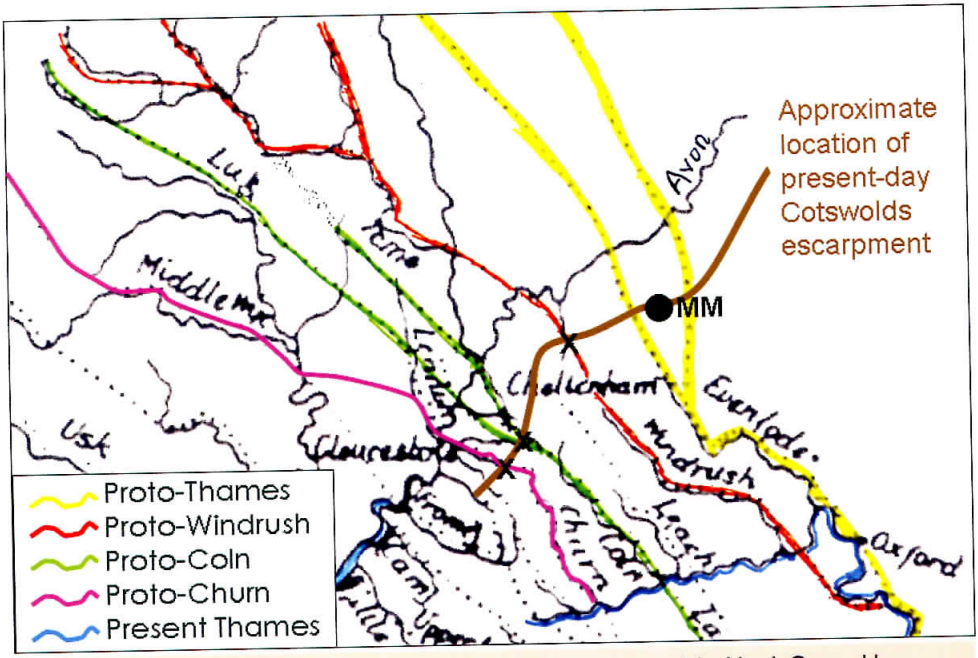

Fig. 2. Map showing the approximate locations of the ancestral rivers of the North Cotswolds (after Davis, 1899). The black 'X's mark the locations where these drainage lines crossed the rising Cotswolds escarpment. MM = Moreton in Marsh. Note that the present-day Avon and Severn Rivers did not exist at the time of these ancestral rivers.

This drainage system was then smothered by the Anglian ice sheet (~450 ka BP) as far southeast as the line of the present escarpment. When the ice melted, large volumes of melt water carved out the Vales of Evesham and Gloucester causing, together with regional tilting up towards the NW, the uplift of the Cotswolds escarpment to something approaching its present elevation.

This article focuses on the North Cotswolds, (Fig. 1) which comprises a major northwest-facing escarpment, reaching to over 300m above sea level at Cleeve Cloud, and a gentle dip slope, down to the southeast towards the present-day valley of the Thames. The morphology of the

escarpment is the result of the gentle regional southeast dip and the resistant nature of the scarp-forming Middle Jurassic Inferior Oolite limestone (Fig. 3).

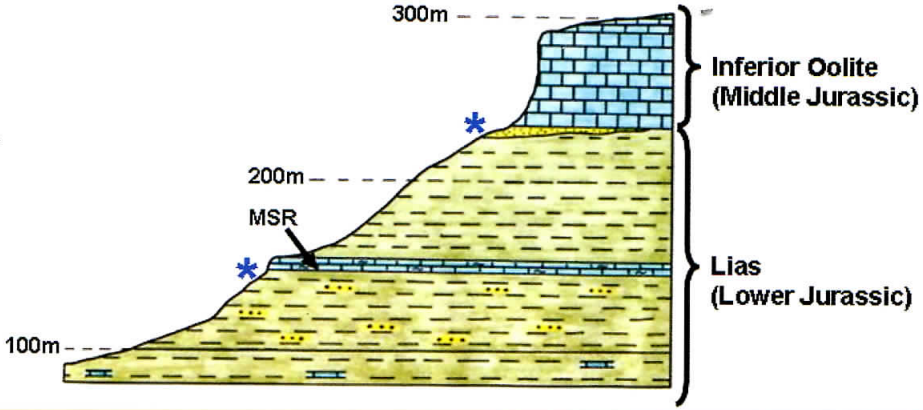

Fig. 3. Geological section over the Cotswolds scarp, Cheltenham area (redrawn from Farrant et al (2014). Blue asterisks denote the location of springs. MSR = Marlstone Rock, a limestone band within the Lias which often forms a ledge-like feature and a springline on the scarp slope. OD = elevation above Ordnance Datum (~ sea level).

The limestone is underlain by Lower Jurassic Liassic shales, which outcrop on the more gentle slopes below the escarpment and extend northwest into the low-lying Vales of Evesham and Gloucester. These Liassic shales are much softer and more easily eroded than the overlying limestones, emphasizing the steep face of the top of the scarp.

The contrast between the rivers and streams on the scarp slope and dip slope is marked (Paul et al, 2018): the scarp streams have steep courses, and deep valleys (combes) which expose much of the Lower to Middle Jurassic sequence of limestones and shales, leading to the presence of many springs and a greater proportion of groundwater in the total (perennial) flow of the streams. This enables the streams to cut back the heads of their valleys into the dip slope. The dip slope streams, by contrast, have a gentle course and the valley does not expose so much of the rock sequence, leading to many fewer springs and a more limited volume of groundwater - hence the streams are smaller, more ephemeral, and often dry in their upper reaches. This contrast in form is apparent on the cross-sections and photographs below.

The low-lying area around Moreton-in-Marsh (on Fig. 2) marks where the palaeo-Thames flowed across the ancestral Cotswolds escarpment (and now marks the watershed between the south-flowing Evenlode and the north-flowing Stour rivers). To the west of Moreton other ancestral Cotswolds rivers must have flowed across the ancestral escarpment. These are now marked by wind gaps: low saddles in the line of the escarpment which were once occupied by sizeable rivers but which are now dry. Wind gaps are found at the heads of three major North Cotswolds rivers, namely the Windrush, Coln, and Churn (but strangely not at the head of the Dikler). Examples include (from North to South, see Fig. 2):-

1. At the head of the Windrush valley, just South of Snowshill, between Oat Hill and Shenbarrow Hill, G.R. 4092 2333.

2. At the head of a tributary of the Windrush, SE of Hailes, at Lynes Barn Farm, G.R. 4062 2278.
3. At Charlton Pool, between Brockhampton and Charlton Abbots, G.R. 4036 2237.
4. At the head of the Churn, North of Seven Springs, between Wistley Hill and Hartley Hill, G.R. 3969 2177.
5. At the head of a tributary of the Churn, just North of the National Star College and SSW of Leckhampton Hill, G.R. 3943 2173.
6. At the head of another tributary of the Churn, just West of the National Star College, near the North end of Crickley Hill. G.R. 3934 2169.

To illustrate the contrast between dip and scarp valleys, I have chosen two examples: the Coln – Isborne wind gap just North of Brockhampton (Charlton Pool) (Fig. 4), and the Snowshill (Oat Hill) wind gap (Fig. 6).

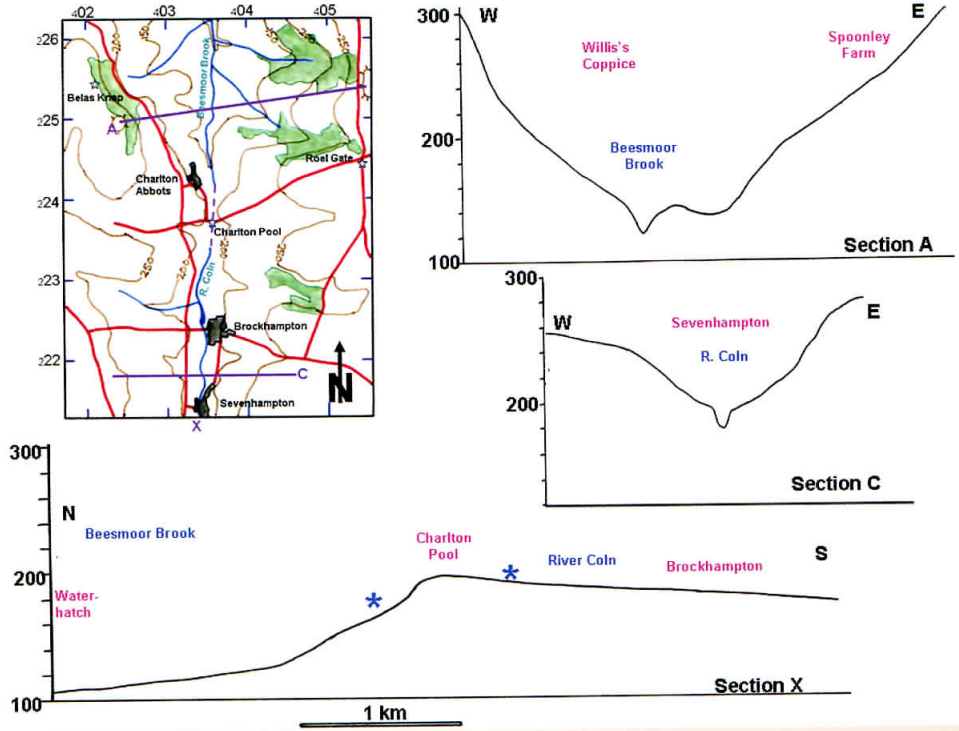

Fig. 4. Sketch map of Charlton Pool wind gap area and cross sections illustrating the contrast between dip and scarp valleys. Vertical exaggeration on the profiles = ~5x, and horizontal scales are the same on each. Blue asterisks locate springs / stream sources. Section X runs N-S along the line of the rivers.

Fig. 4 shows how much deeper and steeper is the scarp valley (Section A) than the dip-slope valley (Section C). The long profile (Section X) runs up the Beesmoor Brook (main tributary of the Isborne River), over the Charlton Pool watershed, and down into the Coln valley past

Brockhampton and Sevenhampton. It is readily apparent how much steeper and deeper is the former than the latter (also apparent on Fig. 5).

Fig. 5. View across the Charlton Pool wind gap from the East (below Roel Gate). The steeper (scarp) slope runs down to the North (Right) past Charlton Abbots; the gentler (dip) slope runs down to the South (Left) towards Brockhampton.

One further example to illustrate the contrasting nature of scarp and dip valleys: Fig. 6 shows the location of the wind gap at the head of the Windrush River near Snowshill, with Section Y running south up the valley of Snowshill Combe, over the watershed by Oat Hill, and down the gentle, open dry valley which leads down to the source of the Windrush at Field Barn. Sections D and F respectively run across the Snowshill Combe and the Windrush valley at the point where the Windrush rises.

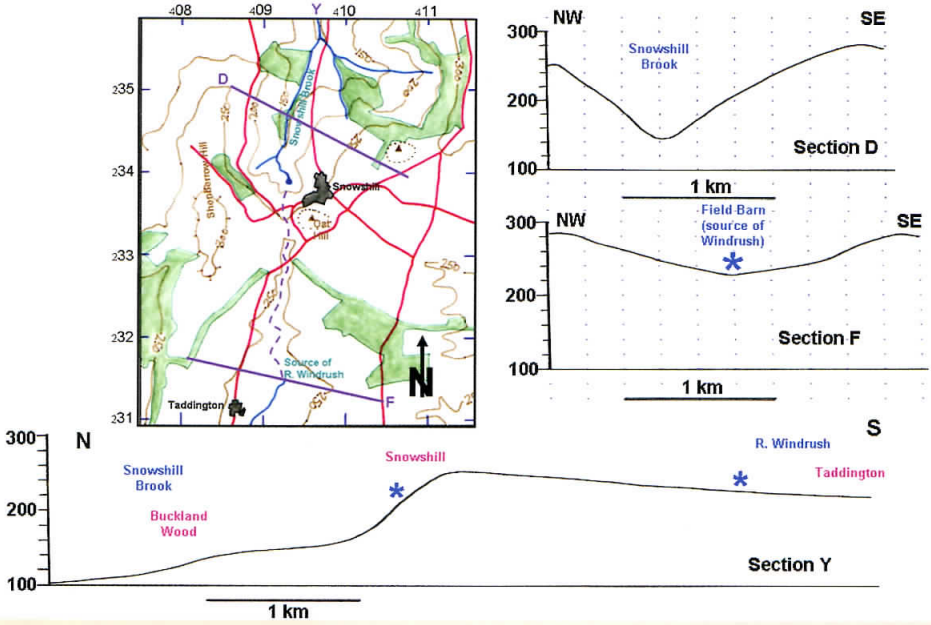

Fig. 6. Oat Hill wind gap: map and cross sections to show the contrast between scarp- and dip-slope valleys. Vertical exaggeration on profiles = ~5x. Horizontal and vertical scales are the same on each section. Blue asterisks mark the location of springs.

This contrast between the scarp and dip slopes is well seen in Fig. 7.

Fig. 7. Views across the steep scarp-slope combe towards Snowshill (Left), and across the gentle open (dry) dip-slope valley that runs South, away from the viewer, to the source of the Windrush near Teddington (Right).

One question remains unaddressed: what controlled the initial location of the scarp slope valleys? It could in part be due to dip reversal as the Cotswold escarpment progressively rose after the Anglian glaciation, but it could also be due to the development of nivation hollows under periglacial conditions in the north-facing slope of the escarpment. Nivation hollows are formed where snowfall is protected in small depressions. Further snowfall compresses the accumulated snow into ice, and melting is limited due to its location on the north face of the escarpment. Below the snow and ice of the hollow, the underlying rock is 'rotted' by freeze-and-thaw activity; the debris is removed by spring melt water streams from under the ice; and the hollow is thus progressively deepened. This would then provide the locus for a post-glacial stream flowing down the scarp.

Once the initial depression is formed, and warmer, post-glacial conditions returned, springs began to flow and coalesce to form the juvenile scarp stream. Headward erosion would then occur through the processes of land-slipping (stream erosion undercuts banks and over-steepens slopes) and spring sapping (where persistent flow of the spring removes fine particles from around the mouth of the spring, causing over-steepening above the spring and headward collapse (Fig. 8)).

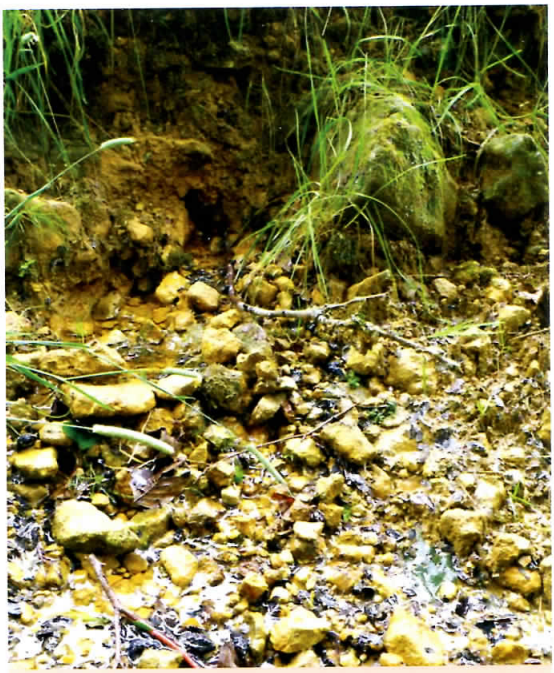

Fig. 8. Spring sapping (on footpath on W side of Snowshill combe)

The same processes take place on the dip slope, but because the gradients and spring

flow are so much less, the effects are much reduced.

The wind gaps described, and the others listed, are key features of the landscape, forming watersheds between drainage to the Thames to the southeast and drainage to the Avon and Severn to the northwest. However, because of the quite gentle, rolling nature of the Cotswolds terrain, the wind gaps are quite subtle features, and so are much more easily discriminated on the 1:25,000 Ordnance Survey maps, or with oblique views on Google Earth, than when actually out in the landscape. Good maps are key to good landscape appreciation!

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