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# LANDSLIP CAVES OF THE MIDDLE COTSWOLDS

by

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## ABSTRACT

This paper gives a brief description of the natural caves that have been formed by landslipping in the Cotswolds between the town of Cheltenham and the M4 corridor. The paper is an overview and includes sites that have previously been published, new data from these sites, as well as several new sites. Surveys of the main caves are presented. It is argued that the mineral deposit described by geologists as "calcite bands" does not represent regional palaeo- water table levels, but has a speleological origin.

## INTRODUCTION

This paper is the second part, of three, of our continuing study of the caves that have formed in the Cotswold Hills by cambering and mass movement. For caves in the Southern Cotswolds, see Self and Boycott (2000). The caves of the Northern Cotswolds are currently being investigated by the authors. For a more detailed study of the processes by which such caves are formed, the reader is referred to Self (1986, 1995).

The term "Middle Cotswolds" is not a recognised geographical area, but has been devised by the authors for their own convenience. The trunk road corridors of the A40 and the M4 divide the Cotswolds Area of Outstanding Natural Beauty into three readily defined geographical units. The "Middle Cotswolds" is the Jurassic limestone upland lying between these trunk roads, that is between Cheltenham in the north and Tormarton in the south. The landslip caves of this report have formed in the limestones of the Inferior Oolite, with one exceptional cave formed in Great Oolite limestone. The geology of the area is outlined in the Discussion, below.

The study area has many springs and also a number of small sinks. In some valley floors, there are subsidence depressions, known locally as "whorley pitts" (Guise, 1877) or "whirley holes". Sites noted in the caving literature include The Needlehole at Upper Coberley near Cheltenham (Richardson, 1941), Oakwell Swallet at Oaksey near Cirencester (Standing, 1964c), Beechtree Swallet and Ashbed Hole at Long Newnton near Tetbury (Ward, 1986a, b and c), and some small sinks to the east of Tormarton (Smart, 1977). No accessible cave passages have been found at any of these springs or sinks. In any case, these wholly karst features do not fall within the remit of this paper.

With the single exception of Frocester Hill Rift, the caves described in this report are all located in small quarries, most of which ceased to be worked by the end of the 19th century. It seems likely that many of the caves were originally explored by these quarrymen, but we have not found any written record of this. The earliest mention of a cave (Tait and Tait, 1886) refers to a site near Wotton-under-Edge that is now lost, probably as a result of infilling of the quarry and a return of the land to agricultural use. Most caves were explored by local people before they were recorded by cavers, e.g. graffiti in Coaley Rift Cave has the date 1954. The first reports in caving journals date from the 1960s, with a scattering of further reports during the 1970s and 80s. Since then no new caves were found until Frocester Hill Rift was exposed in 2003 by a water board trench.

The caves listed here comprise only those sites that are known to the caving community. More are certainly known to local residents and to construction workers who operate in this area. We have also investigated several sites where “gulls” are mentioned in geological reports, though most of these proved to be infilled or were too narrow to be entered. In the text, we use the term *gull* for any joint in the rock that has been significantly opened by mass movement, including those currently blocked with sediments. Not all of these are of a width accessible for a caver of normal build. We use *gull fissure* for openings which are much too narrow to be entered, including open cracks which geologists would term “incipient gulls”. In Gloucestershire dialect, open vertical fissures in the rock are known as “lissens” or “lizens” and can be found in both the Inferior Oolite and the Great Oolite. In historic times, they were often used to dispose of liquid waste, a practice which may have contributed to the Minchinhampton epidemic of typhoid fever in 1844 (Richardson, 1930). “Lissens” probably correspond to our “gull fissures”, as larger openings would have been reported as caves.

## THE CAVES

The caves are described in order from south to north; when caves have a similar latitude, the more westerly is described first. Since the caves often occur in groups, the descriptions are also grouped together. The nearest town (or a named hill plus nearest town) gives the title to these groups, while named quarries are sometimes used as subgroups. This same scheme is reflected in the location map (Figure 1), where each marked site may refer to several caves. Altitudes for the sites have been estimated from Ordnance Survey maps; since the caves are mostly located in the faces of quarries, no great accuracy is claimed for these estimates. Jackdaw Cave, Ball’s Green Upper Mine and Coaley Rift Cave are currently gated as they are important hibernation sites for bats.

### *Wotton-under-Edge*

Blackquarries Hill Alt. 220 m.

Blackquarries Hill lies a little under 2 km east of Wotton-under-Edge and contains a number of small quarries, many now infilled. Bryant (1962) investigated a site he termed “Black Quarrs” on the southern side of the road at ST 775934. He found three small caves, each less than 2 m long, and several fissures containing flowstone. This quarry has now been completely infilled and the field returned to agricultural use. However, Tait and Tait (1886) described with enthusiasm “the road …… past the ‘Black Quarrs’ or ‘Quarries’, where some of the caves vie with Cheddar in glistening stalactites.” The obvious cave-like feature that can be seen from the road, half way up this hill, is a rock shelter in the Cotteswold Sands whose roof is held together by tree roots.

Wintle (1966) describes several small stone mines on the left of the road leading up “Tore Hill from Wotton”. The grid references he gives indicate that this is Blackquarries Hill, not Tor Hill (the name of a long spur running off to the south-west). Inside a small mined chamber on the north side of the road at ST 7793 9347, bouldery gulls with flowstone can be seen but not entered.

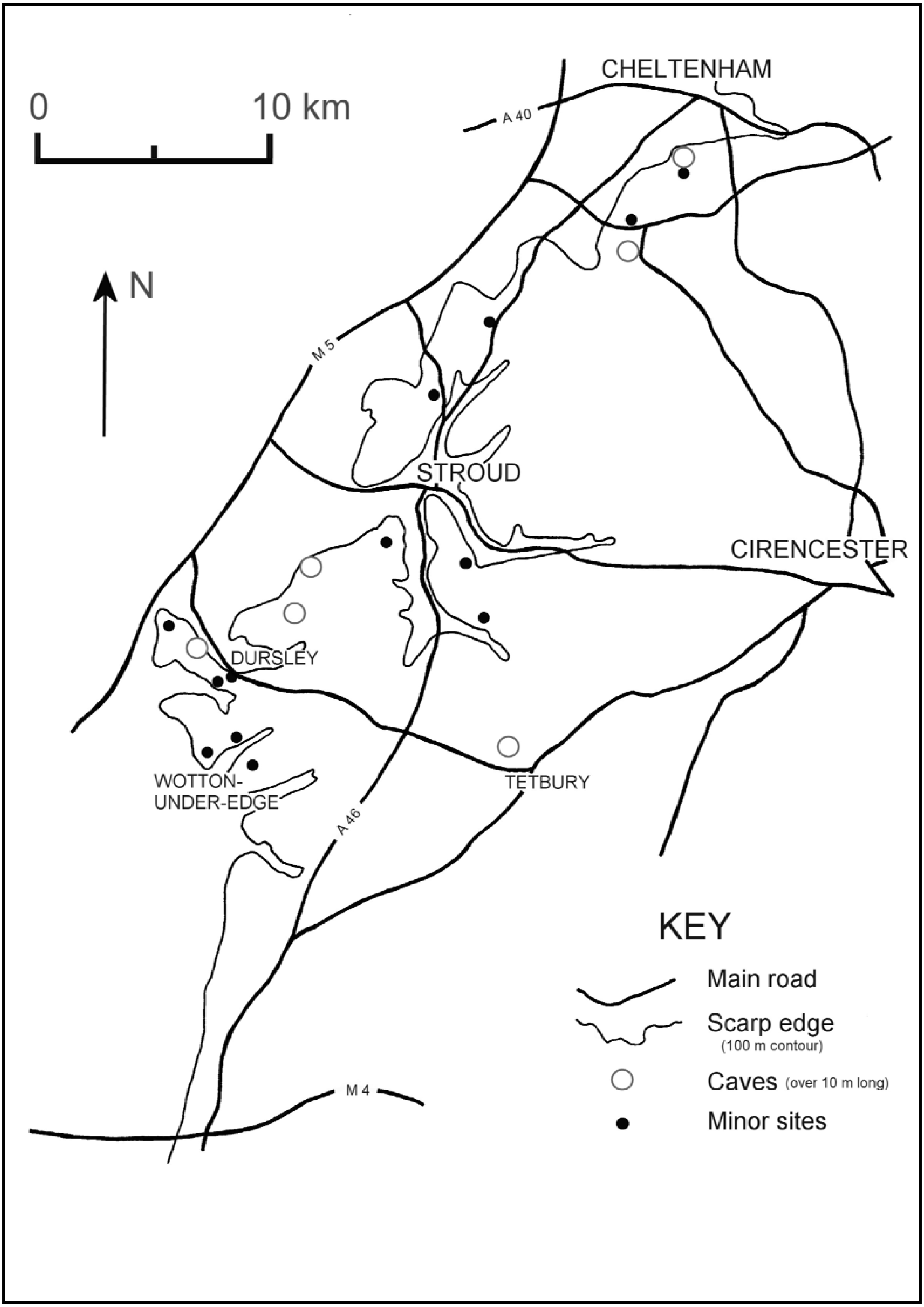


**Figure 1.** *Location map.*

Wotton Hill Alt. 185 m.

Wotton Hill is a prominent but narrow ridge which marks the NW boundary of the town. Wintle (1970) notes “several cave remnants” in a quarry on the west side of the road. He also reports that “Wotton Cave is reputed to have contained stal. etc. which was removed. I believe this cave was in the aforementioned quarry and has since been mainly quarried away”. At ST 7535 9394, in a marked recess in the quarry wall, a gull can be followed to the SSW for 4 m to a choke. A few metres to the left, when facing the quarry wall, there is a choked fissure which may be the remains of Wotton Cave. The walls have traces of flowstone, while the fissure filling is of oolite rock debris, in situ calcite false floors, plus broken and rotated blocks of pool spar. This suggests that more than one episode of mass movement has taken place.

In the same quarry just to the north of these sites, there are several very narrow gull fissures. Some are only seen in the lower part of the quarry face, below a thin clay bed, while others extend up through this clay bed into the limestones above. This shows that mass movement has taken place within the rock sequence, with the clay bed acting as an upper plane of movement for some fissures.

Waterworks Quarry, Coombe Hill Alt. 160 m.

This quarry lies just over 1 km NE of the town and immediately north of the village of Coombe, on the uphill side of a sharp bend in the B4058 London road. The large gull in the centre of the quarry, mentioned by Murray and Hancock (1977), is a surface feature filled with stones. Nearby to the right at ST 7678 9429, there is an obvious gull that is just too narrow to enter. High in the quarry face to the left is a squarish hole of about 30 cm diameter.

*Tetbury*

Hermit’s Cave. NGR. ST 8790 9447. Alt. 130 m.

This cave can be found 2 km NW from the centre of town, on the end of a narrow ridge between two small and normally dry valleys (the most northerly tributaries to the upper River Avon). The cave is in a tiny abandoned quarry on the west side of Chavenage Lane, opposite the large active Veisey’s Quarry on the east side of the lane.

Hermit’s Cave was listed as a “rumoured cave” by I.J. Standing (1964b), but omitted from his revised report (Standing, 1964a). A brief description was given within two reports on karst swallets near Tetbury by Ward (1986a, 1986c), then a more detailed description was published with survey by Ward (1987, 1988).

From the entrance, a crawl under a loose bouldery roof leads to a small muddy chamber. The roof beds are sharply tilted back into the hillside, such rotational movement being a typical near-surface consequence of cambering. The rear wall of the chamber is of solid rock, which forms the side of a rift passage leading to the left to another small chamber and a very unstable region with a daylight connection back to the quarry face. Ward (1987) says he followed this “broken down rift” for a further 15 m by digging but that it “collapsed nearly taking the digger with it”. Only 10 m of cave is now accessible. The cave and its surroundings appear to be popular with local youngsters, so gloves should be worn because of broken glass and burnt rubbish at the entrance. The authors have seen bats roosting in this cave.

The surprising thing about Hermit’s Cave is that it exists at all. It is not on the scarp edge or on the side of a scarp stream valley (like all the other caves of the Middle Cotswolds);

it is on the side of a steep-sided but quite shallow dip slope valley that joins the River Avon. Also, it is in Great Oolite limestone. Location and geology link it with the caves of the Southern Cotswolds, but with one significant difference. Mass movement has taken place on a clay layer within the Great Oolite limestone, rather than on the underlying Fuller's Earth clay. The evidence for this is in Veisey's Quarry, where a prominent blue clay bed of almost 1 metre thickness is seen high up within the limestone sequence, while the quarry floor (20 m deep and still in limestone) can be seen to be at a lower altitude than the nearby valley.

*Dursley*

Breakheart Hill Quarry Alt. 180 m.

Wintle (1970) noted open rifts in a quarry that was actively being worked on Breakheart Hill, to the south of Woodmancote. One of them could have been large enough to enter, had it not been filled with bulldozed overburden. Murray and Hancock (1977) also mention gull development in this quarry, located at ST 755967. The quarry is no longer being worked, and has been partially backfilled. There are a few small holes and narrow gull fissures, both open and infilled, but none are possible to enter. However, on the platform above the SW side of the main quarry, the rotational effects of cambering are well displayed. The result is a series of tilted blocks showing "escarpments" a few centimetres high facing uphill.

Whiteway Quarry Alt. 168 m.

This small quarry overlooks the A4135 main road, 1 km SE of Woodmancote. A prominent gull at ST 7650 9685, noted by Sykes (1977), can be seen from the road in the centre right of the cliff face. It is choked after only 2 m. Flowstone is abundant on the quarry face immediately to the left, suggesting that a conjugate gull has been quarried away.

Stinchcombe Hill Alt. 180 m.

There is a tiny quarry at ST 7425 9878 in a steep wooded hillside, just north of Stinchcombe Hill House. A mined alcove is used as a fireplace by local children. Just inside this alcove, a very narrow gull fissure runs parallel to the cliff face with a veneer of flowstone seen to the right. Sykes (1977) however reports "some stal just inside on LHS. Has been known to draught in summer".

Jackdaw Quarry

Jackdaw Quarry is on the north side of Broadway, a steep lane that climbs from the west side of Dursley up to the golf course on Stinchcombe Hill. The quarry is in woodland and has been developed on two levels, the upper part having a flat grassy swarth in front of it.

Jackdaw Cave. NGR. ST 7490 9789. Alt. 170 m.

The cave is in the centre of the upper (western) quarry and is gated. Jackdaw Cave was listed as a "rumoured cave" by I.J. Standing (1964b), but omitted from his revised report (Standing, 1964a). The cave was first published with a survey as "Dursley Fissure" by Davis (1971). In his report Davis stated that "underground progress is prevented by a roof fall after

18 m", though from his survey the total length appears to be 22 m. The cave is shown as a single passage following joints oriented N and NW. Sykes (1977) gives a very brief description of this cave using the name "Dursley Rift", noting that the rift walls have a "white stal layer over red". His sketch survey, which shows a total length of 22 m, includes a few metres of high level passage at the end of the cave not recorded by Davis.

Jackdaw Quarry Cave. NGR. ST 7495 9788.

There is an obvious cave entrance at the top of a scree slope at the left hand side of the lower quarry. Sykes (1977) describes the cave as "unusually low and flat for the area", his report including a sketch survey. The entrance part of this cave is noted on Davis's survey of Jackdaw Cave. The cave is a gull largely filled with boulders, oriented at 320º, and is exactly 12 m long.

Cave "C". NGR. ST 7498 9788.

A tight cave of 6 m length was recorded by Sykes (1977) at the right hand side of the lower quarry. This cave also appears on Davis's survey of Jackdaw Cave. The cave is a very narrow gull oriented at 320º, made passable because of a fit feature which has been displaced by 35 cm of downward movement of the strata on the northern side. This allows access along a bedding cave for 6 m to a rockfall, with a further 4 m of passage visible in the continuing rift. A strong draught was felt by the authors at the entrance which seemed to dissipate inside, possibly going upwards as a chimney effect.

Sykes (1977) records two more sites "D and E", which are in an alcove in the cliff face between Jackdaw Quarry Cave and cave "C", but gives no details apart from noting flowstone on the quarry face nearby. Cave "D" on the right side of the alcove is comfortably wide but only 3 m long. Cave "E" on the left side of the alcove is quite tight and descends steeply for 4 m, with substantial flowstone deposits inside. It is oriented at 335º, which is a little more to the north than the other caves. Just to the right of cave "E", the cliff is a joint face with two distinctly protruding narrow horizontal lines of secondary calcite. These tiered shelfstones are known to geologists as "calcite bands" (Hollingworth *et. al.*, 1945; Murray and Hancock, 1977). Elsewhere, the tilting of such calcite bands has been used as a measure of cambering (see Discussion).

*Coaley Wood, Uley* Alt. 230 m.

Coaley Wood occupies the upper part of the scarp edge to the north of Uley town. It extends from Uley Bury hill fort for about 2 km NNE to Frocester Hill.

Coaley/ Uley Rift Cave. NGR. ST 7867 9948.

This is the largest cave in the study area and also the best known. However, it suffers from a plethora of names. The cave was surveyed in September 1960 by the UBSS and called Crawley Hill Cave; that survey is published for the first time here, with some additions by the authors. The presence of grafitti dated 1954 was noted in their logbook report. A sketch survey without text was published by Collins (1962), using the name Coaley Cave. The same name was used by I.J. Standing (1964a and b) in his checklist of Gloucestershire caves. Wintle (1966, 1970) briefly describes the cave using the name Coaley Wood Windypit, his first report including a sketch survey. Davis (1971) did not fully explore the cave and offers a brief report and

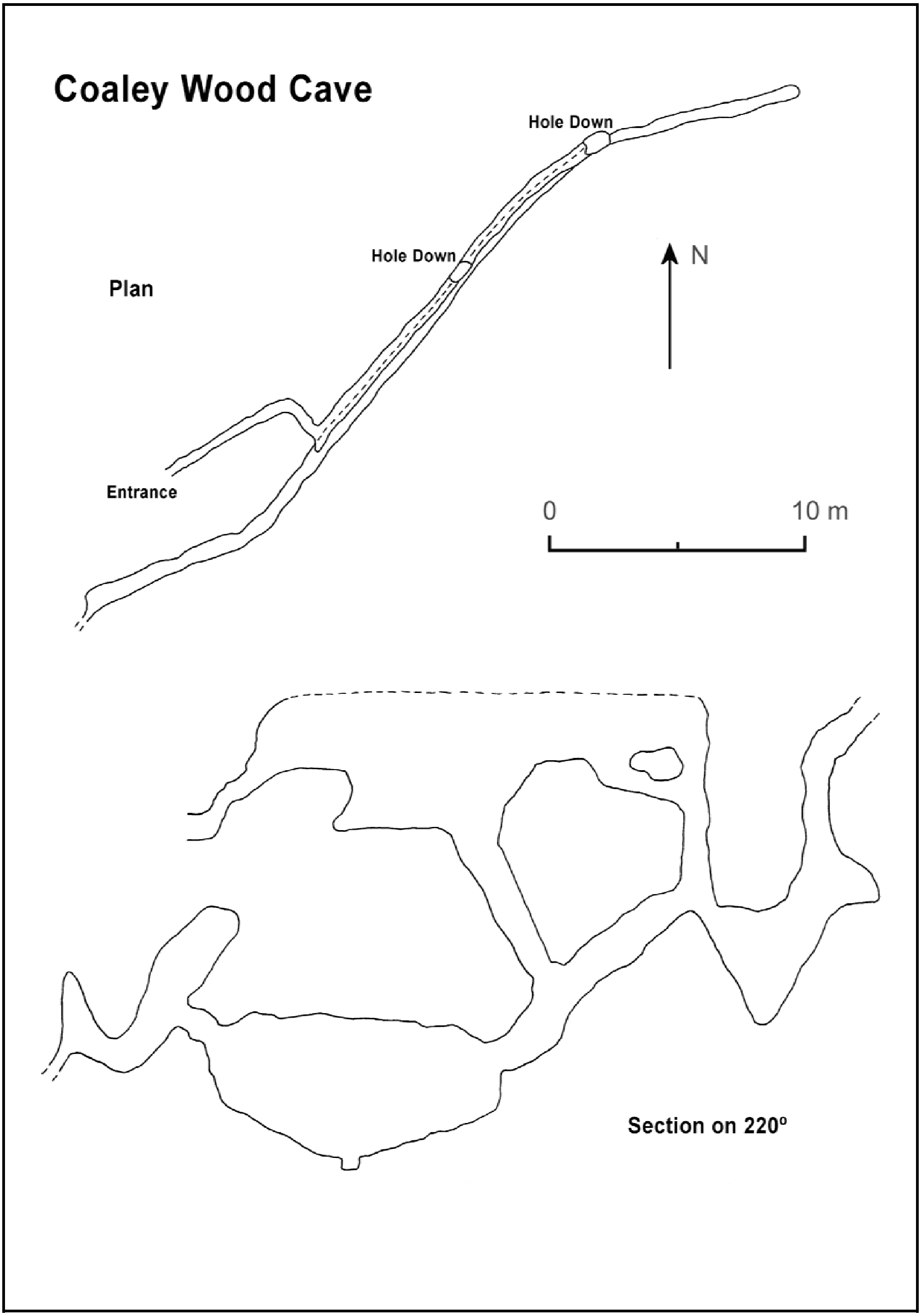


**Figure 2.** *Survey of Coaley Rift Cave, (a) plan, (b) section projected on 220º.*

partial survey under the name Uley Fissure. Sykes (1977) offers a detailed sketch survey of Uley Cave, but with minimal text. Roberts (1982) calls the site Uley Fault, but his discussion on the mode of formation of the cave is manifestly wrong. The fullest description with published survey is by Ward (1989), who uses the name Coaley Rift Cave. For callout purposes, the Gloucester Cave Rescue Organization knows the site as Uley Rift Cave.

Coaley Rift Cave is located about 1 km north of Uley. There is a small car park on the B4066 near the top of Crawley Hill, from which a short footpath joins the Cotswold Way. Following this for 150 m north, a quarry can be seen above and to the right. The cave is roughly in the middle of this quarry, but cannot be seen from the footpath. A steep climb up through trees gains the entrance, which is gated. After climbing up over a boulder pile, the short entrance passage connects to the top of a large rift passage, divided into different levels by wedged boulders. From here, the cave is a single rift passage bearing 30º for most of its length before curving to the north-east at the far end.

Despite being so well-documented, there are serious inconsistencies between the various reports in terms of the orientation and length of the passage. The UBSS survey (Figure 2) shows that the end to end length is 36 m, not the 60 m claimed by some other authors. For much of this length, the cave is divided into an upper and a lower cave by a complete floor of boulders. A total length of about 60 m can be claimed, if route variations within the rift are included. There is a height difference of 16 m between the highest and lowest parts of the accessible cave, with perhaps a couple of metres more seen in the narrowing bouldery roof.

The entrance passage is offset to the north from the main rift, joining it after 7 m. This offset is a consequence of a local high level discontinuity of the jointing, as the main rift joint does not appear in the cliff face of the quarry (and where it should appear, it is hidden beneath a scree slope). The survey also shows an offset between the two levels of the cave, due to the main rift being steeply inclined to the SE rather than vertical. Roberts (1982) claims there is a 4 m vertical displacement between the two sides of the rift, indicating a fault. This cannot be true, since only the offset entrance rift appears in the cliff face, not this “fault”. Vertical displacement due to cambering can sometimes be seen in the Cotswolds, but the authors found no evidence for it in this cave.

Coaley Rift Cave contains an impressive quantity of calcite speleothems. In many places, the walls are thickly encrusted with flowstone. There are also massive broken blocks of flowstone within the boulder infill separating the upper and lower levels. Some small broken stalactites have been incorporated within more recent flowstone. Pool spar crystals are quite common, even high up in the rift, both on rock walls and in voids within the boulder infill. This suggests that at some time, the cave held significant quantities of ponded percolation water.

In the UBSS logbook for 1960, E. Gilbert noted that “flowstone in places shows horizontal ridging reminiscent of the edges of gour pools. These lines are often displaced across joints”. We did not see any evidence of displacement, but in the entrance region of the cave there are good examples of “calcite bands” (Figure 3), sadly damaged by souvenir collectors. Davis (1971) also noted the presence of these bands, but attributed them to “evaporation levels of juvenile water”. Roberts (1982) incorrectly described these bands as “horizontal slickensides”.

At high level near the entrance, some smooth-walled fissures cross the passage, oriented in a more northerly direction. Similar fissures can be seen in the quarry face outside the cave, some with “calcite bands”. These fissures are obviously younger than the main cave passage, indicating that there has been at least two phases of mass movement.

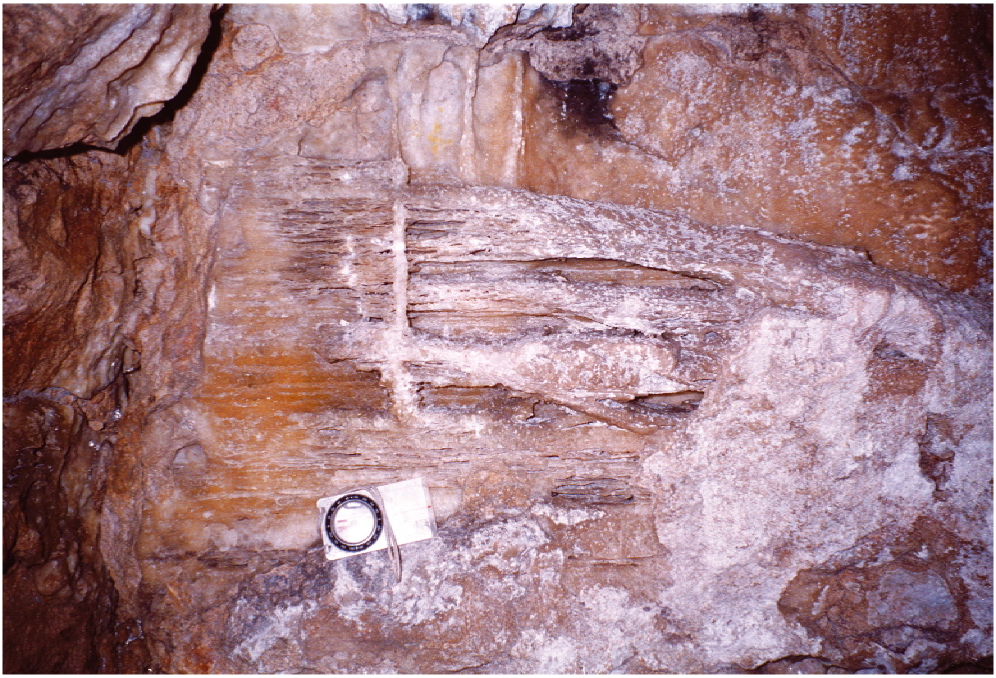

**Figure 3.** *Shelfstone "calcite bands" in Coaley Rift Cave.*

Coaley Wood 2. NGR. ST 7866 9953.

An obvious cave entrance can be seen from the Cotswold Way footpath at the northern end of the quarry, about 50 m from Coaley Rift Cave. Wintle (1970) describes it as a "possibility for a thin person". Sykes (1977) noted the site as cave "B" and describes it as a "tight (!!!) rift with upper and lower entrances, dug ..... far enough to enable a very small caver to retrieve a cold chisel dropped in the top some years earlier". Ward (1989) notes that "there are other rift caves in the same quarry (as Coaley Rift Cave) - none of which can be entered for any distance".

Frocester Hill Rift. NGR. SO 7942 0070.

In the summer of 2003, a Water Board trench was dug along the road on Frocester Hill, about 100 m from the junction of this minor road with the main B4066. This is at the northern end of Coaley Wood, about 2 km NNE of Uley and the same distance ESE from the village of Coaley. The trench revealed a gull roughly oriented along the strike of the hillside (Figure 4), 28.5 m long and 12 m deep. The gull ends in chokes in both directions, but has some interesting features. In places there is a dark brown ferruginous crust, while elsewhere there are moonmilk microgours. At one horizon at the southern end, the oolitic limestone has intraclasts of grey micrite breccia; the rock here is pocketed and corroded, while just below is a bed of soft and muddy oolite containing belemnites that can be dug out of the rock with bare fingers. In July 2004, the cave was filled with gravel and capped as part of a road repair scheme.

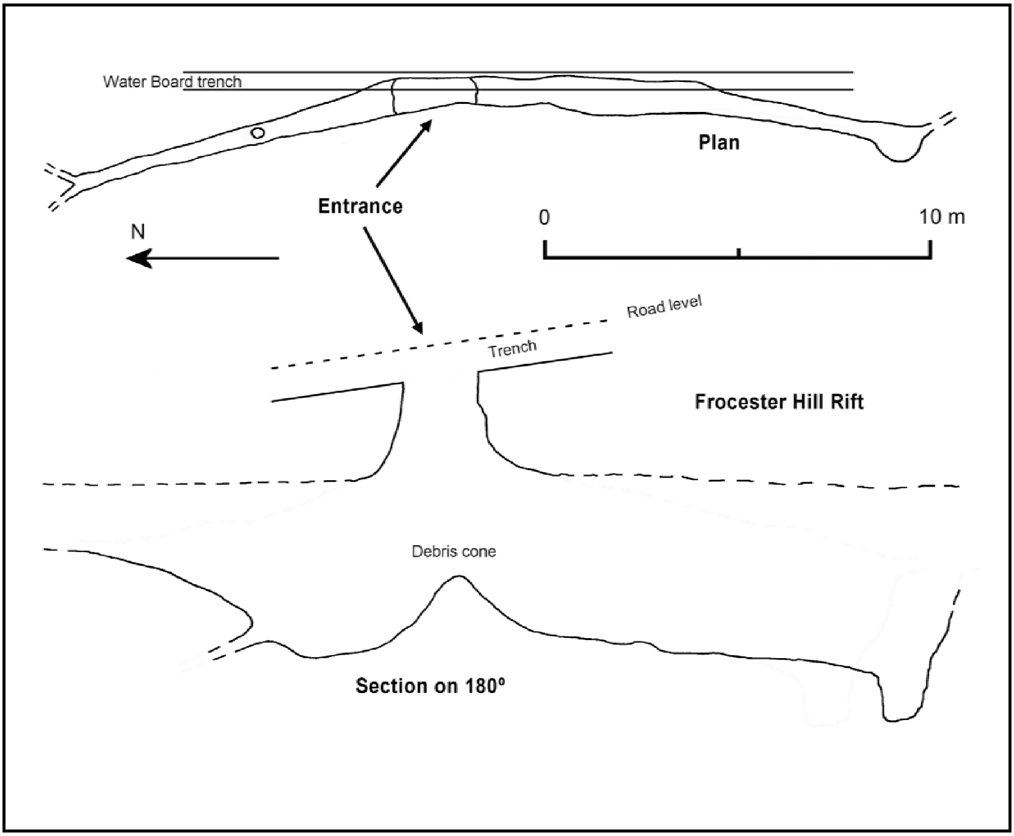


**Figure 4.** *Survey of Frocester Hill Rift, (a) plan, (b) section projected on 180º.*

Frocester Hill 2. NGR. SO 7946 0080.

There are quarry workings immediately east of the road Frocester Hill, at the top of the hill just below the scarp edge. Roughly in the middle part of this quarry, opposite the road junction with Lever's Hill, there is an obvious gull oriented at 160º. It is 70 cm wide at the entrance, but narrowing walls and a steeply rising floor lead to a complete choke after 5 m.

*Nailsworth*

Ball's Green Upper Mine. NGR. ST 8643 9959. Alt. 120 m.

This mine lies 1.5 km east of Nailsworth on the northern side of Gatcombe, a deep valley and tributary to the River Frome. From the valley floor, a minor road climbs up to the hamlet of Ball's Green and the town of Minchinhampton. Some 300 m from the foot of the hill, while still in woodland and before any houses are reached, a lane joins at an acute angle from the left. The mine entrance is on the uphill side of this lane, close to this road junction, at the foot of a small quarry. The land in front of the mine is owned by the National Trust and has been protected by a fence and locked gate. A brief description and sketch survey of the mine has been published by Ward (1992).

The mine has been cut in Lower Inferior Oolite limestone and extends for almost 1 km into the hillside. Throughout this length, and in all branches of the mine, open gull fissures can be seen extending up through the freestone roof. The best developed are oriented around 160º, but none are accessible gull caves. In places, there have been roof falls (or perhaps unstable areas of roof rock were removed by the quarrymen). Here it is possible to see that the oolite continues up for another 2 m or so to a distinctly rubbly layer, above which is a very solid looking bed which forms the roof of these collapsed areas. The narrow gull fissures stop at this rubbly layer, so we have here a very clearly displayed upper plane of movement. It is interesting to note that the miners occasionally made use of these gull fissures, cutting away only one side so that the mined passage has one natural wall. These natural walls show bedding structures in etched relief, indicating that these fissures were once conduits for groundwater before being drained by the developing Gatcombe valley.

The Middle Cotswolds region once had many stone mines, but most have since been sealed and “lost”. Those that remain open are usually gated, with access controlled by bat conservation groups. The authors have not visited these other mines.

*Burleigh* Alt. 190 m.

Murray and Hancock (1977) mention a “prominent gull” in a quarry at SO 862 014, on the northern edge of Minchinhampton Common. The quarry, which is in Great Oolite limestone, has since been partially infilled and the back wall stabilised with a wall of limestone blocks. Only minor gull fissures are now visible.

*Selsley Common, Stroud* Alt. 200 m.

Roberts (1982) states that gull formation is clearly displayed in Leigh’s Quarry on Selsley Common, about 3 km SW from the centre of Stroud at SO 826 025. Dilation of the jointing is mentioned for this site by Murray and Hancock (1977). Apart from several gull fissures, there is a prominent gull in the centre of the cliff, infilled with calcite-cemented debris and with flowstone. On some joint surfaces of the quarry face, there are numerous narrow horizontal lines of calcite shelfstone, stacked one above the other. This is one of the most accessible exposures of “calcite bands” (see Discussion). There are no caves.

*Scottsquar Hill, Edge* Alt. 240 m.

I.J. Standing (1964a) records “2 caves” on “Scotsquar Hill, Stroud”, but gives no further details. The correct spelling is Scottsquar Hill and it is located 1 km SW from the village of Edge.

In a large but shallow quarry, the authors found a gull near the right hand side of the main cliff face, roughly in the centre of the overall quarry workings at SO 8449 0905. 3 m of cave is accessible with a further 3 m visible, oriented at 25º. The roof of the gull in the entrance area is a natural concrete made from surface-derived rubble which has been cemented by calcite-rich groundwater.

Approximately 150 m to the NE of this site, there is a shallow "void" under a large slab of detached bedrock in an area of ground that has been largely stripped of topsoil. This is not a cave.

*Painswick Hill, Painswick* Alt. 245 m.

Painswick Hill extends as a narrow ridge for 2 km northwards from the town of Painswick to a summit on the scarp edge overlooking the city of Gloucester. At the foot of the final slope, a minor road crosses the ridge. At a sharp bend in this minor road, a track leads 200 m south to Catbrain Quarry at SO 867 114. Dreghorn (1967) notes "dip and fault" structures in this quarry, while Murray and Hancock (1977) remark on a fault in the centre of the southern face of the quarry which "is also a major wedge-shaped gull which tapers downwards." No caves are present, but there are a few small voids caused by foundering of the strata. Some gull fissures have an infilling of calcite-bonded sediments attached to one wall; the sediments and the other (rock) wall are now overlain by a flowstone layer. This indicates two episodes of mass movement: the first created a void filled with sediments, the second created a new void which became lined with flowstone. The gulls and their infill have been tilted by a third phase of movement which has caused major cambering and disruption of the strata, with dips of between 15º and 30º to the east.

*Birdlip* Alt. 285 m.

Royal George Cave. NGR. SO 9246 1452.

The cave is at the top of the scarp, just outside the grounds of the Royal George Hotel in Birdlip. From the hotel, the main road turns to the right as it descends Birdlip Hill. A small quarry and a public footpath are soon seen on the uphill side of the road. Before this, climb the steep wooded bank to the right of the quarry to a flat terrace and small rockface that cannot be seen from the road. A large and obvious cave entrance has clearly been modified by miners. Just inside the entrance, a roomy passage can be followed to the right for 10 m, ending just beyond a stone pillar. This passage has clearly been enlarged by extraction of stone. Two much smaller sub-parallel passages can be accessed by crawling. From the entrance it is also possible to climb forwards up a mudbank to a roomy alcove and a passage on the left, which soon closes down. A total of about 35 m of cave can be accessed, but it is not possible to say whether these were all natural passages, linked and of caveable size before they were modified (Figure 5).

*Crickley Hill, near Birdlip* Alt. 235 m.

I.J. Standing (1964a) records "2 known caves" for this location, but gives no other details. The authors found caves in the central part of the cliff on the south side of the hill, overlooking the A417 trunk road. The caves are in "Pea Grit", a pisolitic limestone. Evidence of gulling, but naturally infilled, can be seen on the north side of the hill in the Crickley Hill Country Park car park.

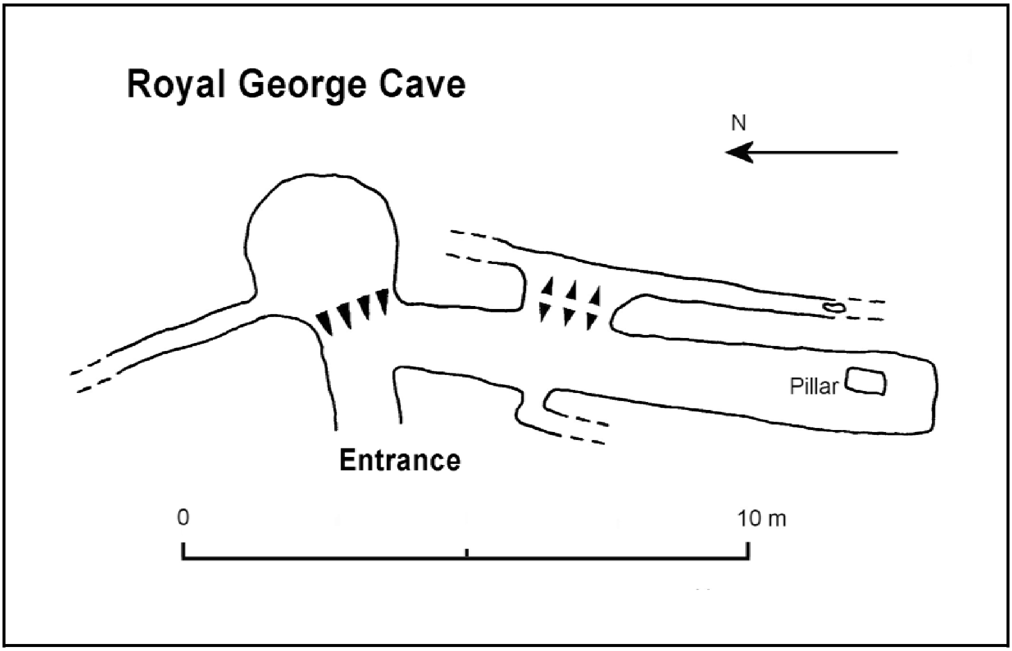


**Figure 5.** *Plan survey of Royal George Cave.*

Cave 1. NGR. SO 9282 1597.

In a small notch in the scarp is a gull oriented 90º, parallel to the nearby cliff edge. It is accessible for 4 m with a further 1 m visible.

Cave 2. NGR. SO 9284 1595.

A bridging climb under an overhang gains a narrow gull oriented 315º, passable for 2 m under the overhang and a further 1 m underground.

Cave 3. NGR. SO 9291 1595.

An obvious cave entrance oriented 320º, with 3 m of very tight passage seen before it narrows abruptly to a fissure.

*Leckhampton Hill, Cheltenham*

I.J. Standing (1964a) records "9 known caves" for Leckhampton Hill, which lies 4 km south of the centre of Cheltenham. Leckhampton Hill has a steep profile on the west and north sides, with the caves all being on the west (scarp edge) side. The north side has been greatly modified by landslipping, particularly towards the east in the region known as Charlton Kings Common. Dreghorn (1967) reports dip and fault structures with bedding angles of up to 60º or 70º, though little rock is actually exposed. Mountains Knoll Wood appears to be a mass of oolitic limestone that has slipped downhill as a unit.

The caves of Leckhampton Hill are individually described in a report by P. Standing (1964), where he divides the hill into four separate regions.

Dead Man’s Quarry (a.k.a. Salterley Grange Quarry). Alt. 250 m.

Cave 1. NGR. SO 9462 1772.

Low down in the centre of the quarry face a cave is passable for 5 m.

Cave 2. NGR. SO 9464 1771.

High on the right side of the quarry, up a stony slope, a cave oriented 160º can be followed for 13 m to a choke. This description differs from that of Standing, who describes a “double squeeze and …… upper and lower passages”. Since the quarry is a popular car park for visitors to Leckhampton Hill, it is possible that there has been disturbance (or removal) of boulders since 1964.

Cave 3.

An obvious gull can be seen in the cliff between caves 1 and 2, with flowstone on the walls. The site is only passable for 2 m and was not recorded by Standing.

The Undercliffs Alt. 250 m.

Cave 1. NGR. SO 9456 1798.

A cave, oriented at 165º, becomes too narrow after 9 m.

Cave 2. NGR. SO 9456 1798.

This cave lies a few metres east of Cave 1, away from the scarp edge, in the back of a quarried embayment. A collapsed entrance area gives two routes, one of which leads to an upper entrance. The cave is 5 m to the end and 8 m length in total.

Cave 3a. NGR. SO 9460 1808 and Cave 3b. NGR. SO 9460 1813.

For his cave 3, Standing describes “a short rift running parallel to the cliff”. The authors found two possible contenders, each only 3 m long.

Cave 4. NGR. SO 9459 1825.

Standing describes “a short entrance passage goes to a chamber with an aven going to the top of the cliff”. This aven has collapsed, leaving a cave a mere 2 m long.

Cave 5. NGR. SO 9460 1827.

A roomy gull oriented at 70º and 8 m long is a popular den for children. Standing noted a “large rift passage going off it”, but this large gull to the left is full of boulders and impassable.

Devil’s Chimney Quarry Alt. 285 m.

Devil’s Chimney Cave. NGR. SO 9470 1837.

Above and to the east of the Devil’s Chimney, a split pillar of rock left behind by the quarrymen, there is another quarry with a prominent gull in the centre of the face. The entrance is situated 10 m up a chimney climb which, though not technically difficult, has some loose rock and is somewhat intimidating. Once past a large block, a descent of 6 m (handline useful) is made onto a rubble pile. A roomy rift oriented at 160º has upper and lower passages in both directions. The lower passage to the south ends at a choke and aven, the lower passage to the north descends at 45º to a choke near the cliff face. The end to end length of the cave is 20 m and depth 13 m. Including the upper passages, the total length is 35 m (Figure 6).

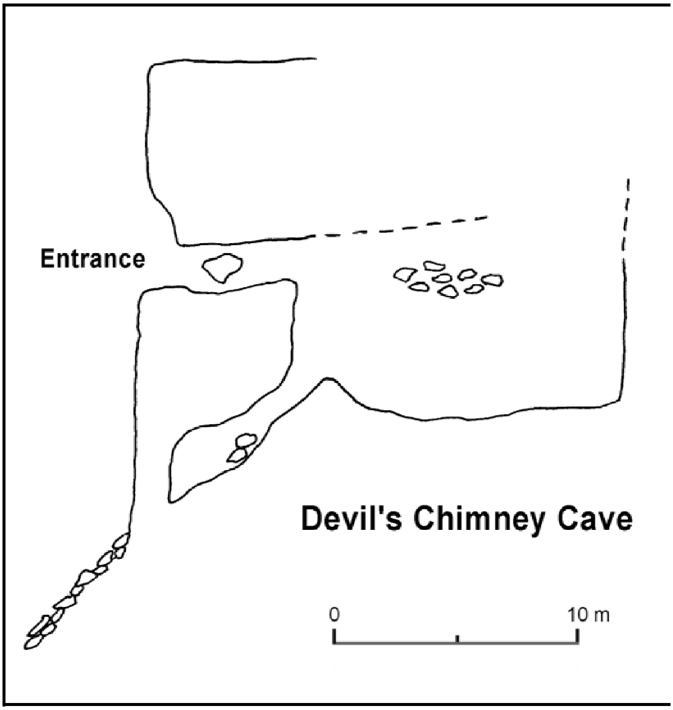


**Figure 6.** *Survey of Devil's Chimney Cave, section projected on 160º.*

Cave 2. NGR. SO 9472 1840.

There is an obvious hole beneath a small elder tree, high on the left hand side of the quarry. It is possible to climb down to it from above, but a lifeline is recommended. Standing describes the cave as 5 m long and "extremely tight".

Daisybank Quarry

Alt. 250 m. (lower)

Standing calls this Daisey Bank Quarry. He mentions a 3 m long "rock shelter at the base of this quarry", but there are two lines of cliffs. The lower line has been largely obliterated by landscaping work and the upper line has no caves.

## DISCUSSION

The Cotswolds Area of Outstanding Natural Beauty has been divided by the authors into three separate regions. Although the boundaries between the regions are artificial, there are distinct landscape and geological differences between them. In the Middle Cotswolds region, the Inferior Oolite limestone caps a great indented scarp overlooking the broad valley of the lower River Severn as it flows across Triassic sandstones and Lower Lias clays (the Charmouth Mudstone Formation). Overlying these soft sediments, the Middle Lias comprises sandy silts, topped by a shelly ferruginous limestone, the Marlstone Rock Bed. This harder bed forms a conspicuous ledge (or under-edge) in front of the escarpment. The scarp face itself is formed of Upper Lias sediments, a basal clay, then a fine yellow sandstone called the Cotteswold Sands, part of the Bridport Sand Formation.

Capping the Upper Lias sediments, Inferior Oolite limestones form the top of the escarpment and the first part of the dip slope. To the east, younger rocks of the Fuller's Earth clay and the Great Oolite limestone outcrop further down the dip slope. The mass movement caves of this report are in Inferior Oolite, located on the scarp edge and on the valley sides of scarp streams. Some of these scarp streams have cut back into Great Oolite territory, causing extensive landslipping (Witchell, 1868), but no caves. The only cave in Great Oolite is in a dip slope valley of the River Avon drainage system.

The Inferior Oolite attains a maximum thickness of 90 m in the vicinity of Cheltenham, at the northern edge of the study region, and steadily decreases in thickness to the south. Passing into the Southern Cotswolds region, in the vicinity of Bath the formation is so diminished that it gives rise to only a minor feature in front of the scarp of the more massive Great Oolite. Here, the steepest slopes are on the over deepened valley sides of the River Avon and its tributaries as they cut through the Great Oolite into the underlying Fuller's Earth clay. In the Southern Cotswolds region, landslip caves are exclusively developed on these valley sides in Great Oolite limestone. We could perhaps regard Hermit's Cave (Tetbury) as an outlier from the Southern Cotswolds region, since it has formed on the Great Oolite dip slope at the junction of two tributary valleys of the upper River Avon.

The caves of the two regions are thus developed in different strata, but appear very similar because of similarities of lithology between the Inferior and Great Oolite limestones. However, there are no extensive gull caves in the Middle Cotswolds region. Several caves are more than 20 m long, but the longest (Coaley Rift Cave) is a mere 36 m. This compares poorly with the Southern Cotswolds region, where there are half a dozen caves longer than this, including Sally's Rift (345 m) and Murhill Rift (317 m, see Appendix). A possible reason for this difference in development between the two regions is found not in the limestones themselves, but in the underlying strata on which they cambered. Brown (1991) found that pyrite oxidation in the upper horizons of the Fuller's Earth clays in the Bath region has caused chemical leaching of their calcite content. This greatly reduces their shear strength and allows mass movement at much shallower camber angles than in comparable Upper Lias valley slopes. This results in much more extensive foundering of the strata.

The Upper Lias is not a uniform formation across the Middle Cotswolds region. In the south around Dursley it mostly comprises Cotteswold Sands, resting on a base of clay. Progressing north, the clay increases in thickness at the expense of the sandstone, so that at Leckhampton Hill it is a clay formation topped by a thin sandstone unit. Despite these differences in lithology, the authors of this paper found no apparent difference in the frequency of occurrence of gull caves or in their development across the region.

One unresolved problem is found in the Stroud region, where the River Frome and its tributaries have cut back so deeply into dip slope territory that Fuller's Earth and Great Oolite strata are exposed on the valley sides. These hillslopes are marked as "foundered strata" on geological maps, but despite steep gradients no gull caves are known. Witchell (1868) offers a significant observation: "it is scarcely possible to find a combe ....... in which there are not one or more slips. Sometimes they are stationary, but frequently in winter, after heavy rains and severe frost, they move a little forward, until, in the course of time, the masses reach the bottom of the valleys, where they are eroded by the streams." These Fuller's Earth valley sides are unstable, with active rotational landslips destroying any older mass movement features. Yet comparable valley sides of the River Avon have remained relatively stable for more than 350 kyrs, according to U/Th speleothem dating from the gull cave Sally's Rift (Self, 1995). This topic needs further study.

It is worth noting that there are no karst caves in the study area, despite there being many springs and small swallets. Phreatic solution channels can occasionally be found, for example in the cliff face just to the north of Hermit's Cave (Tetbury), but they are small and insignificant. Groundwater movement has predominantly been along the open fracture system of the joints. Dye traces in the Great Oolite dip slope at Tormarton have rapid peak travel times, but long low-concentration "tails" (Smart, 1977). This shows that some joints are acting as major water conduits, but that there is also considerable dispersion into subsidiary fissures. We see supporting evidence for this in the gull caves of both the Southern and Middle Cotswold regions, and also in quarries and stone mines where gull fissures can be examined. The first joints to open are oriented roughly NW/SE and NE/SW and invariably have (pre- mass movement) solution features on their walls. This has left its trace in the etching out of current bedding and other sedimentary structures. Sometimes this solution is much more pronounced in one joint set compared with the other, indicating the direction of palaeo- gound-water movement (Self, 1995). Younger, narrower gull fissures of other orienta-tions show little corrosion. An example of this is the N/S fissure set in Coaley Rift Cave. If all the joints of the NW/SE and NE/SW sets are available to transmit groundwater, there is no chance for integrated karst conduits to develop.

**Figure 7.** *Charlie Self (arrowed) standing in the entrance to Devil's Chimney Cave.*

THE ORIGIN OF "CALCITE BANDS"

Calcite flowstone veneers on NW/SE and NE/SW joint surfaces are common through-out the Cotswolds. They are found in gull caves and also in gull fissures exposed by quarrying. They have formed in exactly the same way as flowstones in karst caves by deposition from gravitational calcite-rich groundwater on the walls of an air-filled underground cavity.

In a few localities in the Cotswolds, there is another type of secondary mineral deposit known to geologists as “calcite bands”. These are sequences of thin calcite shelfstones stacked one above the other (Figure 3). Good examples can be seen in Leigh’s Quarry (Selsley Common, Stroud), beside Cave E (Jackdaw Quarry, Dursley) and in Coaley Rift Cave (see above for details). At these sites the bands are horizontal, but where significant cambering has occurred they dip in the direction of camber. Calcite bands were first described by Hollingworth *et. al*. (1945) in the Northampton ironstone field: “The calcite bands clearly result from deposition at the surface of evaporation of underground water and so mark former water-levels. Their present inclination from the horizontal, therefore, gives a measure of the valleyward tilting that has taken place since their formation”.

How do “former water-levels” produce tiered shelfstones? If we first consider the case of a palaeo- water table, calcite bands would represent a part way stage in the de-watering of the jointing. This would be at an early stage in the evolution of the landscape, before any mass movement occurred. An open joint network, part-filled with supersaturated groundwater, would deposit shelfstone at the rest water level. However, the overwhelming evidence from throughout the Cotswolds is of open joints carrying *undersaturated* groundwater to springs.

The calcite bands must therefore have formed after de-watering of the jointing and be the result of local ponding of percolation water behind sediment blockages. This explains why they are uncommon and why one joint surface may have bands but not the next. In Jackdaw Quarry (Dursley), there are two bands near Cave “E”. A few centimetres below the lower band, a jumbled pile of shelfstone fragments has been cemented to the joint wall, marking the position of the sediment floor of a former gull or gull fissure. In Coaley Rift Cave, calcite bands have overgrown some small ribs of flowstone (Figure 3). This shows that they are a result of a recent local ponding event, since they are younger than the normal wall flowstone.

So how do such narrow bands form, stacked one above another in such close proximity? If they represent a series of former water levels, then they show either a rising or falling sequence. In karst caves, deposition on the rims of gour dams causes a steady increase in water level in the pool behind, but this does not produce calcite bands. Tiered shelfstones therefore must show falling water levels. A sediment dam could be slowly eroding away, but this seems unlikely, as saturated percolation water would tend to coat the dam in flowstone, binding the sediments and creating a gour. In the specific context of landslip caves, where extension of the strata may cause a partial roof collapse and/or the entry of surface-derived materials, a sediment dam could form suddenly. With continuing movement, tiered shelfstones may be a record of incremental widening of the jointing with associated settling of the dam.

It would be possible to use U/Th speleothem dating methods to find the age of these bands and (by inference) a date for the mass movement. Sampling across a sequence of bands would give an indication of how mass movement progresses. A small age difference would mean that cambering occurs quickly as a discrete episode, a large difference would suggest it is a continuous slow creep.

Murray and Hancock (1977) attempted to use calcite bands to determine the extent of cambering in the Cotswolds. They found that some superficial veneers “are locally thickened into two sets of ridges ........ which are generally at right angles to each other”. They studied these bands in Catbrain Quarry, Painswick and claim that one set formed at successive ground water levels, while the other indicated preferential routes for water seeping vertically down from above. Both sets are now tilted. The bands are “about 1-2 cm in width”, which is much thicker than the shelfstones noted in this paper and also much thicker than those shown in a photograph in Hollingworth *et. al*. (1945).

In the south-western corner of Catbrain Quarry, a gull fissure can be seen with two sets of (now tilted) calcite protruberences. These “horizontal” and “vertical” bands are of normal flowstone and bear no resemblance to shelfstone. The localised thickening of the “horizontal” flowstone is quite marked, but corresponds to small projections of the substrate. These projections are corrosion features from a time when this joint once carried undersaturated groundwater under phreatic conditions. Later, when supersaturated percolation water began depositing flowstone, these sub-horizontal bands of rock interrupted the downwards flow of this water. A longer residence time for water passing over a rock band, plus greater degassing of $CO_2$ from projections, can explain this localised thickening of flowstone.

At Catbrain Quarry, cambering has tilted the strata by between 15º and 30º, the calcite bands being similarly tilted. When plotted on a stereographic projection, Murray and Hancock found that the “horizontal” bands all lie on a common plane which is within a few degrees of the bedding. This was taken as proof that the limestone was essentially horizontal when the bands were forming and that deposition ceased before cambering occurred. In view of the above argument, it seems that they have only shown that the current bedding here is closely aligned to the general dip of the strata.

However, there are a second set of bands which are “vertical”, also tilted by cambering. Gravitational water does not deposit a uniform coating of flowstone on steep or vertical walls, but tends to collect into streams which then deposit vertical ribs of flowstone. This enhanced growth is due to a local increase in the supply of solution along the flow path. Murray and Hancock state that the two sets of bands are “generally at right angles to each other”. Since we know that one set must originally have been vertical, their data does show that the limestone was essentially horizontal when flowstone was being deposited.

The tilting of calcite bands and flowstone ribs shows how much cambering has taken place since they were formed, but there is no way to determine the extent of any previous movement. This is a disappointing result for palaeogeography. The tilting does however give a *minimum* estimate of the total camber. Higher estimates can then be found using other factors, such as the difference between local and regional dips.

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## APPENDIX

Since publication of our paper *Landslip Caves of the Southern Cotswolds* (Self and Boycott, 2000), Murhill Rift has been greatly extended. The new passages are a complex of rifts on several levels, all located close to the cliff edge and now with a total of seven natural entrances. 287 m of gull rift were surveyed, with an estimated further 30 m unsurveyed (Reaich and Beckett, 2001). This includes several gull passages in Murhill Mine, from where a voice connection was established with Murhill Rift.

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