Proc. Univ. Bristol Spelaeol. Soc., 1985, 17 (2), 153-174

TWO GULL CAVES FROM THE WILTSHIRE/AVON BORDER

by

C. A. SELF

Henry's Hole, Box Hill near Corsham, Wiltshire	N.G.R. altitude length	ST83616946 135m A.O.D. 120m
Sally's Rift, Gully Wood, Monkton Farleigh near Bathford, Avon	N.G.R. altitude length	ST79416501 155m A.O.D. 345m

ABSTRACT

Descriptions and surveys of two caves in the Great Oolite Limestone east of Bath are presented. Henry's Hole is a mass movement cave, a gull structure, which runs into part of an old freestone mine. The mined workings allow access to other gulls which are not open to the surface. Although the surface strata appear mainly intact, the beds at depth are foundered in a complex manner which suggests that the gulls seen are part of a high level secondary disturbance, with major gulling (unseen) at greater depth. Sally's Rift is an entirely natural network of gulls, formed by the opening of two sets of joints. The cave has been known for many years but the only previously published survey is an incomplete Grade 1 sketch. Sally's Rift shows a most unusual feature for a gull structure, a bedding cavity which is thought to be caused by block subsidence between vertical and inclined joints. Two phases of mass movement can clearly be demonstrated by the presence of a collapsed false-floor in the cave.

To help distinguish between caves formed by mass movement and those formed by solution, the characteristic features of gull caves are described. A morphological classification of gulls is also offered, based on and extending a system devised by Hawkins and Privett (1981). The theory that gull formation is caused by gravitational sliding on cambered hillsides is discussed and generally endorsed.

INTRODUCTION

Mass movement as a mechanism for cave development has received little attention in British cave literature. One reason for this neglect must be the nature of the caves themselves, which typically are narrow rifts containing loose boulders and rarely match the beauty of caves formed by flowing water. Perhaps more important is the fact that few mass movement caves can be explored for any distance, so their discoverers rarely trouble to survey them. Sally's Rift is exceptional, being one of the longest gull caves that have been reported, and comparing favourably in terms of both length and complexity with the windypits of North Yorkshire (Cooper *et al.,* 1982). Though 'windypit' is a name widely used in the north of England, the correct term for a mass movement cave is 'gull structure'. Individual passages are known as gulls and the process by which favourably oriented pre-existing fracfures (usually joints) expand is called gulling.

As mass movement caves are not formed by flowing water they are often found in rock types not normally considered suitable for caves. The Yorkshire windypits, for instance, occur in sandstone (Cooper *et al.,* 1982). Henry's Hole and Sally's Rift are developed in Great Oolite Limestone, a porous rock of Jurassic age sometimes known as Bath Stone. Although the two caves are in different counties they are both located in the narrow limestone upland region that lies to the east of Bath (FIG. 1), geologically a southern extension of the Cotswold Hills. The most common location for a gull cave is high on the side of a valley. Sally's Rift is on the east side of the River Avon, opposite the village of Claverton. Henry's Hole is on the south side of the By Brook, a tributary of the Avon. These rivers have cut deep into the sequence of clays (the Fuller's Earth Series) that underlie the limestone and provide a base upon which gravitational sliding can take place. Although there is a gentle regional dip to the ESE, cambering has caused a local dip towards the valleys to develop. This is illustrated in FIG. 2 and explained in more detail later. Cambering is extensive in the Bath area and the Geological Survey records 45 km^2 of foundered strata. The main cause of this is that the River Avon and its

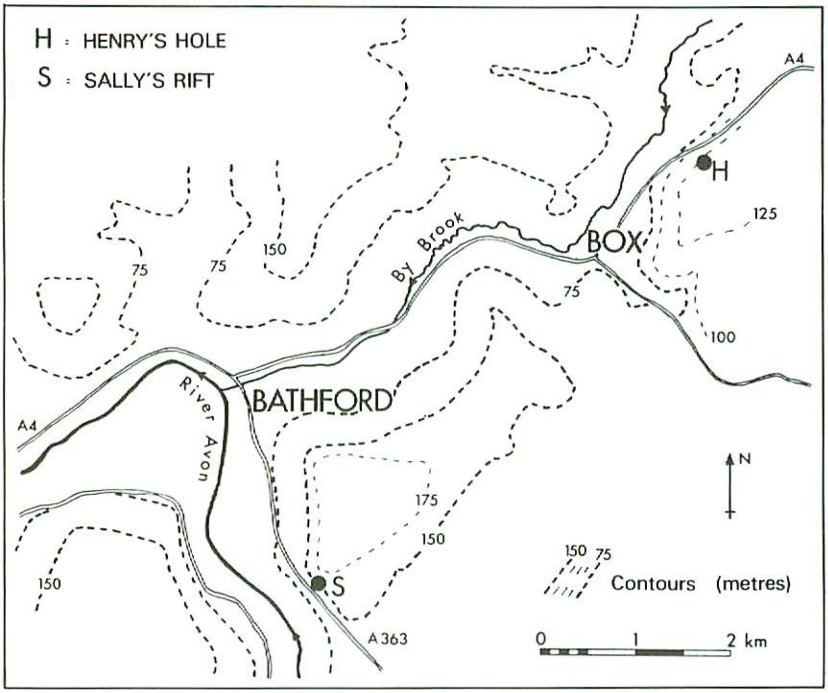

FIG. 1 — AREA MAP: THE REGION JUST EAST OF BATH

tributaries are over-deepened, vertical erosion having been faster than lateral valley slope development. Valley depths can be as much as 200 m.

There are two theories to explain this over-deepening. The simplest (Hawkins, 1980) is that most of this erosion took place during the glacial periods of the Quaternary when there was heavy surface run-off from melting snow. A very attractive alternative theory (Barrington and Stanton, 1977) is based on a longer time-scale and involves river capture. According to Stanton, the headwaters of the River Thames once rose on the hillsides of eastern Mendip, flowing through Bradford-on-Avon and

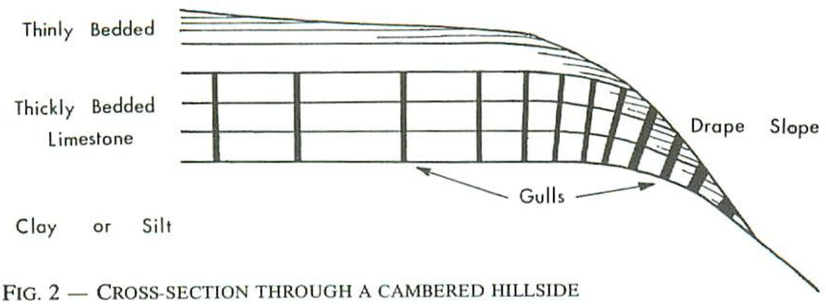

FIG. 2 — CROSS-SECTION THROUGH A CAMBERED HILLSIDE

Chippenham to join the present valley of the upper Thames at the Swindon Gap. A much smaller stream, the By Brook, drained to the Bristol Channel through Bath at a lower level. The two systems approached to within 5 km of each other at Claverton, the Thames flowing north-east at the top of the escarpment and the By Brook flowing south-west at its foot. River capture occurred with the formation of the Claverton Gorge. The By Brook became the Avon with a flow ten times greater than before and its bed was rapidly worn down, undercutting the valley sides to cause the major landslipping seen around Bath. Massive knick points worked up all the streams causing more foundering and the proto-Thames reversed its direction almost to Swindon, vastly augmenting the new River Avon. No dates are offered for these events but they are thought to pre-date the periglacial slurrying and mass flow which removed huge quantities of clay and further deepened the valleys. The age of the cambering is thought to be Wolstonian (Chandler *et al.*, 1976) though younger cambering of late Devensian age has been identified in the Cotswolds (Thomas, 1981).

In view of the extent of foundered strata in the Bath area one would expect there to be many gull caves. Apart from the two caves recorded here, plus some minor sites explored by Tucker (Tucker, 1965 a), any gull caves open to the surface seem to be too small to be worth reporting. The rest must be choked at the entrance by surface-derived material and are thus hidden from view.

HENRY'S HOLE

Location

Henry's Hole lies at the foot of a small quarried cliff, part of Tyning Quarry, at the bottom of the garden of 4, The Tynings, Box Hill near Corsham, Wiltshire. One hundred metres to the east lies Hazelbury Quarry, familiar to cavers because Quarry Entrance to the Box Stone Mines used to descend from its eastern corner. Unfortunately this entrance has now been infilled. The original mine entrance to Tyning Quarry lies 30 m north-east of Henry's Hole and has also been filled in.

Historical

The Romans were the first to begin quarrying near Bath for freestone, but it is St. Aldhelm who is credited with discovering Box Ground Stone in the latter part of the 7th century (Price, 1984). Hazelbury Quarry dates from this time. The scale of these operations was quite limited and the main phase of quarrying in the Box–Corsham area did not begin until about 1770. It is likely that Tyning Quarry dates from this period. In local parlance, 'quarry' refers to both surface and underground workings and most quarries also contain mines.

The other quarries on Box Hill, plus those on Quarry Hill, were worked underground until they connected in a maze of tunnels now known as the Box Stone Mines. The mined workings of Tyning Quarry do not connect with these other mines, although they are very close. It is not known quite when stone production ceased, although a survey of the Bath Stone quarries (Anon., 1895) includes Tyning Quarry. The entrance, in the garden of the house Little Tynings, remained open until it was filled in 1961.

In 1982, Ted Lloyd began clearing rubbish from a tip at the bottom of his garden at 4, The Tynings. When the rubbish was gone he found an open rift, a gull structure, which led down into some mined workings, part of the old Tyning Quarry. He invited a friend, Andy Sparrow, to explore the mine and a brief note and Grade 1 sketch duly appeared in the *Belfry Bulletin,* newsletter of the Bristol Exploration Club (Sparrow, 1983). The author first heard of the site in the spring of 1983 and surveyed it with members of the U.B.S.S. The cave is named after a relative of Ted Lloyd.

Description

The entrance to Henry's Hole (FIG. 3) lies at the foot of a small cliff quarried into the Jurassic Limestone. A vertical drop of 2 m lands on an earthy slope running into the cliff in a narrow rift passage whose roof, as far as can be seen, remains at the level of the entrance. This entrance rift very soon constricts forwards and a low grovel under the unstable right-hand wall gains a second, parallel rift. This second rift can be seen to continue back towards the cliff face, but at a slightly lower level. Forwards the second rift descends steeply and is passable in its lower part where it is about 30 cm wide. The upper part is much narrower and the top of the rift is soon lost from sight. Narrow cracks in the rift walls are due to the opening of cross joints, giving a blocky and somewhat unstable appearance to the passage. Some very small stalactites may be seen if they are searched for. At a depth of 7 m below the entrance a low chamber of considerable blocky breakdown is entered; it was called Five Ways Chamber, for convenience when surveying. Evidence of mining is apparent.

The most obvious way on from Five Ways Chamber is to the left between large breakdown blocks to a rift, Climber's Gull, seen in the roof of the mine. This gull is too narrow to be entered at this point, but the mined level may be followed to the right to where it is possible to climb up into the gull, which soon ends at a bouldery cross joint.

Returning to where this narrow gull is first seen, the mined workings are about 1 m high. Smooth saw-cut rock faces can be seen and blocks of waste stone are stacked to form roof supports. A few metres to the north-west yet another gull is met, with another fracture a short distance beyond. This far fracture is a trivial feature, of interest only because it is completely filled with subsoil debris and rootlets. The more significant gull, just before it, is here little more than a crack in the roof, but the mined level follows it, lowering for a while to a flat-out crawl over waste stone backfill. (Here a crawl to the right returns to Five Ways Chamber.) After a short sloping descent the First Chamber is reached, entered either over or under a huge collapsed block. The chamber is 7 m long and up to 5 m wide. The gull leading to the chamber

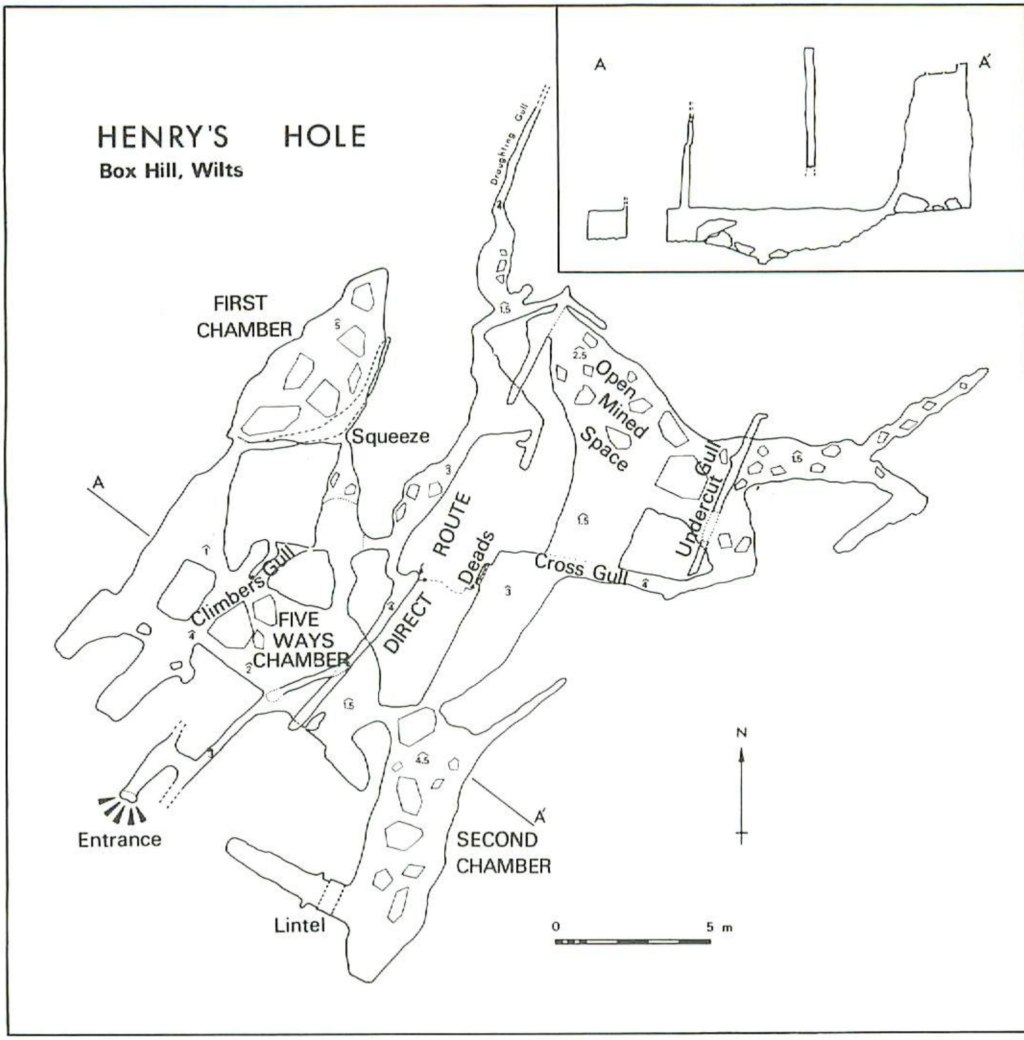

FIG. 3 — SURVEY OF HENRY'S HOLE

(Both Henry's Hole and Sally's Rift were surveyed with compass, tape and clinometer to the nearest degree and to the nearest 10 cm. Though normally this would merit Grade 5, no fixed stations were marked on the cave walls so Grade 4 is being claimed for the surveys. Closed loop errors in Henry's Hole were found to be less than 1%.)

runs across the roof on the long axis and large breakdown blocks litter the floor. The floor is lower at the northern end of the chamber, which here is perhaps 5 m tall. There may well be mine workings below these boulders but such extensive collapse has effectively sealed them.

Beginning again at Five Ways Chamber, a low and unpleasant grovel can be seen at floor level almost opposite the entrance rift. The roof rises after 2 m at a cross joint which gives a visual connection on the left to the end of Climber's Gull. With the aid of this cross joint, by climbing up through boulders to the right, a connection may be made to Direct Route (described later). Forwards from the cross joint is a roomy space among the boulders, and a climb up and then squeeze down enters the east corner of First Chamber.

Direct Route offers the shortest although perhaps the most difficult route to the northern end of the cave and rises through the roof of Five Ways Chamber, roughly continuing the line of the rift leading back to the entrance. This tight ascending rift is unusual in that it is not vertical but leans 10° to the east. A crystal vug may be seen in the right wall of the inclined rift as it rises steeply to enter a substantial gull through a hole in the floor. This gull may be followed back to the south for 3 m, where it chokes with mud and boulders. Curiously, there is no other connection to Five Ways Chamber, which lies directly underneath, separated by at the most 3 m of rock. Forwards to the north the gull is 4 m tall and 40 cm wide, with a thin veneer of flowstone in places on the walls. The gull ends at a cross rift where a dribble of water enters from the roof on the right and exits via a very small hole in the floor on the right. Some small stalactites may be seen in the roof. A hole on the left, just below roof level, gives a tight squeeze into a continuing passage.

The right wall of this continuing rift passage is solid but to the left is an area of bouldery breakdown. A descending route to the left gains the open space mentioned earlier, near the east corner of First Chamber. This is not the most obvious route, however, as the rift may be followed forwards to the north, descending to a breakdown area of large boulders. Some good fossil echinoids may be seen here. Ignoring a route to the right, which doubles back on itself and closes down, the way on is low under a boulder and then over boulders to a more open area. The floor here is the collapsed remains of the roof of the old mine.

Continuing forwards to the left soon leads to the foot of a tall gull which often has a strong draught. The gull ascends steeply to the north over muddy chockstones but becomes increasingly narrow with height. It also continues forwards below the chockstones. At the farthest point reached, 4 m in and 3 m up, it is only 20 cm wide, but continues narrower above for a further 4 m. The gull meanders away to the north, the jointing being less regular in the upper reaches than it is in the lower. Straw stalactites and cave coral deposits on the walls are plentiful. This is the most northerly part of the cave and also the nearest to the original mine entrance (Tyning Quarry).

Returning to the open area south-east of this gull, a route may be followed to the east, rising through a letter-box squeeze to gain a roomy gull near its northern end. The floor of this gull rises to the south and ends in a choke at a point directly over mined workings. The gull narrows upwards with wedged chockstones. At its northern end it degenerates into a collection of impassable fissures, mostly at high level, while a well-decorated gull runs off for a few metres to the south-east with cave coral deposits overlain by a white flowstone veneer.

Across the gull from the letter-box an easy climb down gains an open area of mined workings. This is one of the deeper parts of the cave, 9 m below the entrance, and saw-cut rock faces can be seen beneath the breakdown blocks. There are several ways on from here, but since there is a much easier way to reach this part of the mine they will be described later.

Beginning again at Five Ways Chamber, the least inviting of the possible routes is a flat-out crawl on the right, rising to where a large boulder obstructs the way on. Wriggling round to the right, the northern end of a chamber is gained, large breakdown blocks littering its floor. At its maximum dimensions this Second Chamber is 9 m long, 3 m wide and 5 m high. Unlike First Chamber which is a collapse feature, Second Chamber was mined, the bouldery floor being caused by subsequent breakdown. In the south-west corner of the chamber a stone lintel (PLATE 1), supporting a neatly piled stack of mining 'deads', leads to what was probably a mineworkers' back entrance. A gull crossing this mined passage has been filled from above with clean angular cobbles of what appears to be mining spoil. Although Second Chamber was mined there is still some residual evidence of gulling, not least in the fractures running up into the roof. At the north-east corner a gull runs off, ending in bouldery breakdown when it meets a cross joint.

At the northern end of Second Chamber the mined area continues, but at a lower level. A crawl over a large boulder gives access, and an alternative route is to wriggle left from the crawl from Five Ways Chamber. A roomy boulder-floored passage leads on. A dribble of water splashes on to a wall of deads on the left, the water last seen in the nearby Direct Route. Just beyond, a major east-west cross gull forces the route to the right. The mined level ducks under the left wall of this gull, low, wide and bouldery, to join the open mined area mentioned earlier and so provide yet another alternative route to the northern end of the cave. The east-west gull provides the best route to the eastern end of the cave. Though very narrow at height, the gull is roomy at floor level, having been modified by mining. Where it meets a strong north-east/south-west joint the gull wiggles across it and continues on a new, slightly more northerly bearing. The gull can be seen here to have a solid roof, but the mined workings do not follow it and it is still very narrow. The mine floor, littered with breakdown boulders, now leads north, almost immediately passing under another gull, Undercut Gull. The climb up into this gull is made difficult by the undercutting of the mine, although a few small stalactites provide some recompense for the effort. To the south-west the gull soon chokes, very close to the point where the main easterly gull changes its course. To the north-east the gull ends at a cross joint; part way along its course an interesting fracture leaves to the right. Very narrow and slightly inclined to the vertical, this side fracture has a different roof bed to the main gull.

Returning to the mined level, a descending route to the left over boulders gains the open mined area that connects to the northern extensions. Forwards and then round to the right a very bouldery route eventually reaches yet another gull. At its eastern end the gull narrows and is choked with muddy boulders. A rising slope of similar boulders gains the choke at the western end. *En route* to this gull a way may be found heading north-east amongst boulders, but cannot be followed far. This is the most likely region to find a connection into the main mine workings, but collapse in this area seems extensive.

The total length of Henry's Hole is a mere 120m, although the complicated interconnection between mine and gulls makes it seem longer. The deepest parts are the mined levels at the northern and north-eastern ends of the survey. They achieve a depth of 9m below the entrance.

SALLY'S RIFT

Location

Sally's Rift lies in thick woodland near Monkton Farleigh on the same hillside as Browne's Folly Mine, the second longest freestone mine in Wiltshire after Box. The cave is 1km south of Browne's Folly and is best approached from the A363, the main road that runs from Bathford to Bradford-on-Avon. Leaving Bathford on the A363, the road climbs a long hill with steep woodland rising to the left. Near the top of the hill there is a lay-by and a notice proclaiming the woods to be private. Heading directly uphill from the lay-by, after 50m a track is met which follows the contours. Turn left, to the north. After 100m leave the track and climb steeply up through jungly undergrowth for perhaps 70m. Here a discontinuous line of small cliffs is met, some with open cracks and fissures. One of these is Sally's Rift, distinguished by its alignment parallel to the cliff face.

Historical

Sally's Rift is entirely natural and has been known to the local villagers for some time. In the 1930s a local man found a body in a cave and during recovery of the body, a remnant of rotten sisal rope was found in the entrance (Batstone, pers. comm.). From the description, this site resembles the climb down into Main Rift of Sally's Rift. These early visits aside, the local people appear to have been reluctant to explore further than the pitch, a good place to lob stones, leaving the first recorded descent to members of the Axbridge Caving Group in 1964. A Grade 1 survey appears under the title 'Gully Wood Cave no 3' in their Journal for that year. A brief note on further exploration can be found in their Newsletter of May 1965, but the information offered is sketchy and incomplete (Tucker, 1964, 1965a and b).

Boulder Chamber and the passages beyond were found after considerable digging over the period January 1970 until November 1972 by a small group, of whom Chris Batstone and Robert Scammell were regular members. With a view to comparing the gulls of Sally's Rift with those seen in Henry's Hole the author and members of the U.B.S.S. surveyed the cave in the spring of 1985.

The popular name Sally's Rift is used in this paper, being well known both to the locals and to the caving community. The name derives from 'Sally in the Wood' which appears on Ordnance Survey maps. The Axbridge title has never been widely accepted.

Description

Sally's Rift (FIG. 4) is the longest of a number of small caves whose entrances lie in a low cliff hidden in thick woodland. The main entrance of Sally's Rift is a small rock shelter with a narrow slot in its floor. By means of a crawl under a boulder the foot of this slot may be gained easily and a rift passage continues across a hole in the floor to an 8 m pitch. To avoid the pitch, the hole in the floor, which proves free-climbable, lands on a steep earthy slope running down to a boulder lying at the foot of the pitch. Here a large passage is met, at its maximum some 15 m tall and 2 m wide, and inclined at 80° to the east. Called Main Rift by its original explorers, it is slightly out of alignment with the entrance passage and can be followed in both directions. The route to the south will be described later.

Taking the obvious route forwards to the north, the muddy stony floor descends and then rises again under large boulders wedged high across the rift (PLATE 2). After 10 m a major junction known as Cross Rift is met; this will be described later. After 20 m and a short climb a passage off to the left leads to a choke, while after 30 m Main Rift itself becomes choked. Just before the end of Main Rift a narrow rift passage leaves to the right. Although the narrow cracks at the end of this rift are too tight to be followed, they lie very close to another part of the cave (Parallel Rift, described later) and an aural connection has been established.

Cross Rift is a major crossroads with the left-hand passage rising steeply to daylight. The passage narrows with height and becomes exceedingly tight before it issues as a crack in the cliff face. One arm of a 'T' section is present at the top of this rift, suggesting vertical displacement. The right-hand passage is decorated with brown flowstone and has chockstones wedged across it in places. It ends after 7 m at a T-junction with another major north-south passage, Parallel Rift. To the right, Parallel Rift soon chokes with boulders. A continuation of Cross Rift, offset to the south, is easier to enter by climbing and soon leads to a small and very bouldery chamber known as Thornton's Grotto. Various cracks fail to lead further. Another small chamber lies directly above Thornton's Grotto and is entered by climbing.

Turning left into Parallel Rift and following it to the north, a passage leaves to the right after 10 m while Parallel Rift itself continues a further 15 m to a choke. The passage on the right soon narrows to an easy squeeze. Just before the squeeze a very narrow rift leaves to the left, only passable at floor level where it is a little wider. Through the squeeze a more substantial rift may be followed to the left, Second Parallel Rift. This chokes after 12 m, but again there is a gull on the right leading deeper under the hillside. This eastward-heading gull is surprisingly roomy, being a full metre wide. Although many of the north-south gulls described so far have been as wide as this, the east-west gulls are generally narrower. The floor of this gull descends and then climbs steeply to emerge in a small chamber floored and roofed with boulders. The most obvious route out of Boulder Chamber is to the left, where a crawl over boulders gains a rift well-decorated with white flowstone. Decorated Rift soon chokes. At the opposite end of Boulder Chamber from Decorated Rift a bouldery crawl has been pursued

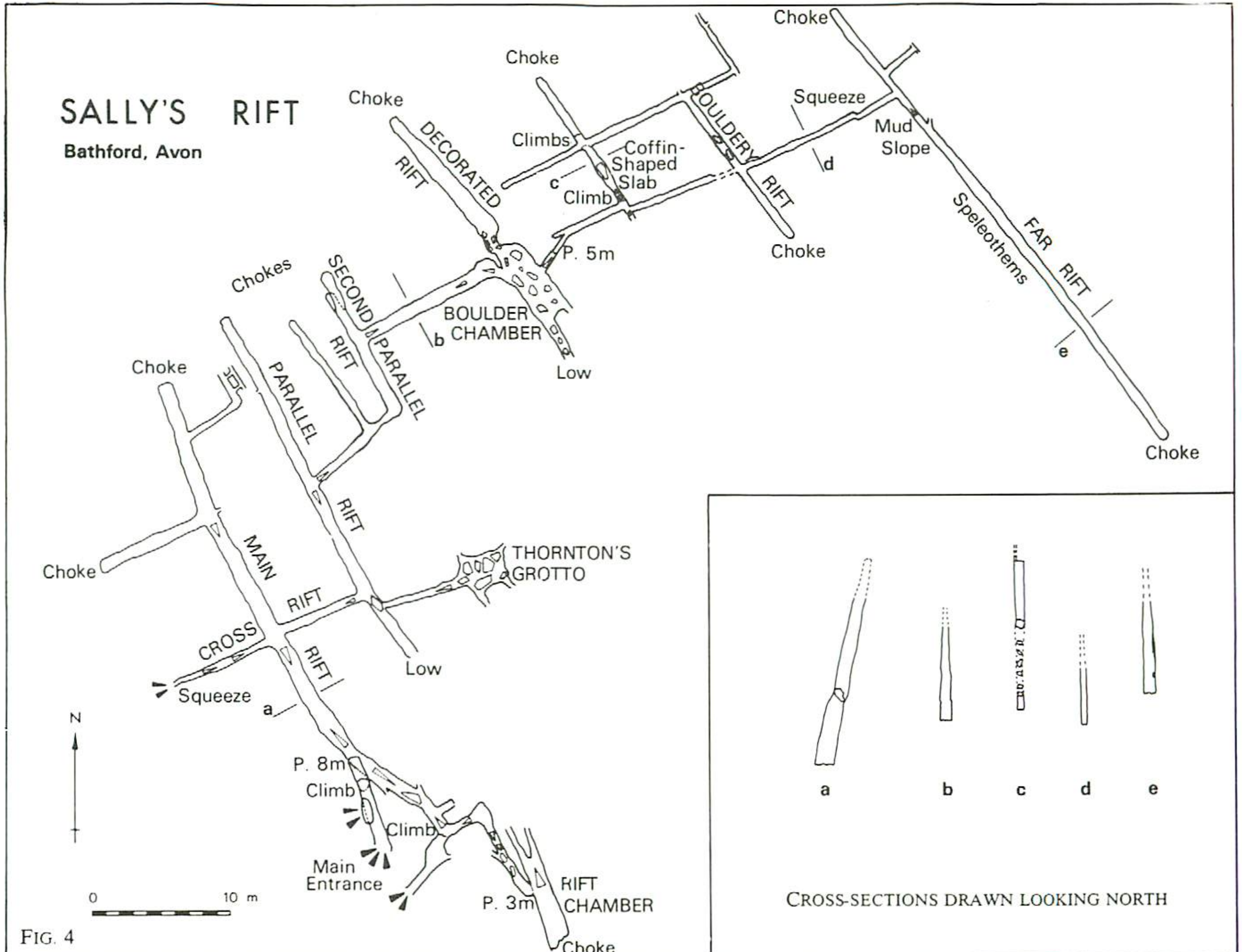
SALLY'S RIFT
Bathford, Avon
Choke
Choke
Choke
Squeeze
Mud
Slope
Climbs
Coffin-
Shaped
Slab
Climb
c
d
DECORATED
RIFT
BOULDERY
RIFT
Choke
P. 5m
Chokes
SECOND
RIFT
PARALLEL
BOULDER
CHAMBER
b
Low
Speleothems
FAR RIFT
e
Choke
PARALLEL
RIFT
Choke
MAIN
RIFT
Choke
THORNTON'S
GROTTO
CROSS
RIFT
Low
Squeeze
a
N
P. 8m
Climb
Climb
Main
Entrance
RIFT
CHAMBER
P. 3m
Choke
0
10 m
a
b
c
d
e
CROSS-SECTIONS DRAWN LOOKING NORTH

FIG. 4

for several metres, whilst a dangerous climb up through the roof of the chamber gains another chamber of similar size.

The way on to the rest of the cave was found by digging boulders out of a narrow crack in the north-east wall of Boulder Chamber, almost opposite the point of entry to the chamber. The passage descends steeply to a 5 m pitch, an awkwardly narrow chimney which proves a strenuous and difficult freeclimb for those unwilling to carry tackle. At its foot a gull continues east into the hillside, becoming narrower at a cross joint and then suddenly becoming impassably narrow, though a wider continuation can be seen ahead. At the cross joint a climb up of 7 m between wedged boulders gains a roomier part of the joint. A way suddenly becomes apparent that was invisible from below, leading north-west over an inclined Coffin-Shaped Slab to an easy, bouldery climb down in two stages. Rifts to the left and ahead both end in chokes. The rift to the right (PLATE 4) passes a bouldery side passage on the right (Bouldery Rift) to end at a very narrow cross rift, passable to the left for a few metres.

Bouldery Rift is a far more important side passage than it at first appears, for within a few metres a cross joint is met whose right-hand branch is the impassable slot which necessitated the climbing detour. The continuation of Bouldery Rift ends at a choke while left at the cross joint a narrow rift heads deeper into the hillside. After 9 m, at a cross joint that has not appreciably opened, the rift passage is offset a few centimetres to make a squeeze. Shortly after this the passage ends at a T-junction into a major passage of 1 m width, Far Rift.

The left-hand branch of Far Rift soon chokes, while a spur off this branch ends at a tight cross rift. The right-hand branch of Far Rift climbs a mud slope to reveal at roof level a profusion of speleothems and the remnants of an old false floor. Just beyond this point an impassably narrow rift leaves to the north, a very rare direction, while the main rift continues for a further 30 m, roomy and well decorated. Some of the old false floor is still attached to the walls as knobbly calcite edges encrusted with stalagmites and stalactites (PLATE 3) but in the main it has broken and fallen in boulder-sized lumps across the passage. These flowstone blocks are massive, some being 25 cm thick and 1 m or more across. At the southern end of Far Rift an unstable boulder choke marks the current end of the cave.

As was mentioned at the beginning of the description, Main Rift also continues south from the pitch at the entrance. From the boulder at the foot of the pitch a climb down and then back up over a huge collapsed block leads to a passage whose floor continues to rise steeply. At a cross joint the rift turns to the left to enter a tiny chamber, while high to the right at this point daylight can be seen through a low crawl in the bedding, caused by block subsidence of the floor (PLATE 5). (This entrance is recorded as Gully Wood Cave no 3A by Tucker (1965b) but it was not then connected to the main cave). From the tiny chamber a narrow bouldery rift descends to the right, entering a rift chamber at a height of 3 m. The climb down is undercut and is extremely difficult without tackle. Forwards the chamber ends at a choke, while in the opposite direction it lowers and splits into two tight descending cracks.

The present length of the cave is 345 m, but numerous boulder chokes offer the possibility of extending the cave by digging. The one serious effort made so far, in Boulder Chamber, was well rewarded. The boulder chokes are of typical breakdown debris, being an unsorted mixture of mud, stones, and boulders. Occasionally they may be penetrated at high level, as in the case of the crawl south from Boulder Chamber, where they tend to be looser and less earthy. The lowest part of the cave is in Main Rift between the pitch and Cross Rift. Here it is 15 metres below the entrance. While most passages appear to have the same altitude at roof level, the varying amount of infill material determines their accessible depth. Exceptions are the collapse chambers of Thornton's Grotto and Boulder Chamber where both floor and roof are at a higher level than elsewhere in the cave. An average passage height for the rifts is about 10 m.

STRATIGRAPHY AND STRUCTURE OF THE TWO CAVES

In the area of study the geological succession begins with the Fuller's Earth, a predominantly clay formation of Middle Jurassic age, 44 m thick (Chandler *et al.,* 1976). Above lies the Great Oolite Limestone which consists of hard shelly oolitic limestone with some current-bedded oolite freestone beds. The first 10-12 m of these beds were sometimes mined (though not in this area) and so are known as the Stone Beds (Price, 1984).

In the Box area the succeeding 4 m are the main oolite freestone, known locally as the Ground Bed. A coarse shelly oolite of a little over 1 m thickness is known as the Roof Bed, for obvious reasons, although it also has a pseudonym, 'Bastard Stone'). Above lies another economically important sequence of beds, 4-5 m thick, called the Box Corngrit (to the west these beds become the Combe Down Oolite, to the east the Corsham Stone). Further hard shelly beds and more freestones (the Bath Oolite) lead up into the Upper Rags, so called because they are of no economic value.

By correlation with the nearby Box Stone Mines, the stratigraphy of the beds seen in Henry's Hole may be determined. The mined parts of the cave were cut in the Ground Bed and since only the upper parts of the workings are visible, the beds seen are the topmost beds of the Ground Bed. The gulls are seen in the roof of the workings, cutting through the Roof Bed, and extend up into the Box Corngrit. In two places the gulls extend all the way to the surface, at the entrance and somewhere along the length of the draughting rift at the northern end of the cave. The other gulls stop short of the surface, most becoming increasingly narrow with height. Sometimes the flat roof of a gull can be seen and occasionally two gulls meet, using different roof beds (as in Undercut Gull). Due to the rubble debris that litters the mine floor it is not possible to follow the gulls downwards to see if they continue below the mined workings. It seems likely that some gulls do continue down, for a short distance at least. However, the mine passes underneath some gulls, Direct Route for example, with the Roof Bed intact. In Henry's Hole, the Fuller's Earth clays lie 12 m or more below the lowest levels seen. Since the junction with the Fuller's Earth is a major plane of slippage on hillsides throughout the region it seems likely that there will be gulling beneath Henry's Hole associated with this plane. The visible gulls can then be considered part of a complex, near-surface secondary disturbance with bed-over-bed sliding taking place along many different bedding planes within the Ground Bed, Roof Bed, and the Box Corngrit.

The stratigraphy of Sally's Rift is more difficult to determine. A rough estimate may be made by correlation with Browne's Folly Mine, which lies 1 km to the north, and with a small unnamed mine entrance in the woods about 300 m to the south-east. The altitude of Sally's Rift puts the entrance at about the same point in the stratigraphy as these mines, that is the Ground Bed, or perhaps a little higher. At its lowest point Main Rift is some 15 m below the roof level at the entrance and must be very close to the underlying Fuller's Earth clays. The floor level is usually much higher than this, rising and falling as a result of material that has collapsed from the roof, much greater infill occurring when two gulls cross. This is to be expected, as joint junctions are natural points of weakness. The roof level appears to stay at the same level in the stratigraphy, but observations of passage heights in such tall, narrow rifts are somewhat arbitrary. The close proximity of major joints has caused some stoping in the region of Boulder Chamber and Thornton's Grotto; however the steeply rising hillside outside the cave ensures a roof over these chambers. The roof of Far Rift is estimated to be 25 m below ground surface. Just inside the most southerly entrance there is a cavity (PLATE 5), bounded above and below by bedding planes, which appears to have formed by block subsidence rather than stoping. A similar cavity can be seen bounding the Cross Rift entrance on its northern side.

Within the cave flowstone is common, but near the entrances it is badly contaminated with allochthonous (extraneous) material. Flowstone quality improves with depth beneath the hillside, the speleothems in Decorated Rift being pure white. In the deepest part of the cave, Far Rift, there are massive flowstone boulders which once were part of an extensive false-floor. The internal structure of these old flowstones show that for most of the time during their deposition the percolating water was free of sediments, though there were periodic muddy phases which show as inclusions and gritty boundaries within the calcite. Deposition of clear calcite means that the percolating water did not contain soil-derived debris, which in turn suggests that the rocks overlying these deeper rifts have not been greatly disturbed. Possibly the roof bed seen is the true top of the disturbance, with little or no secondary gulling above. The fine fraction of the floor debris must therefore originate within the cave, derived from clay horizons between the more massive limestone beds. During particularly wet periods of climate these fine sediments pollute the percolation water to produce the bands seen within the flowstone.

The remains of a false floor 2 m above the present floor level in Far Rift suggests that there were at least two phases of mass movement. The first phase created the gull and left a floor (or boulder-bridge false-floor) upon which flowstone was deposited. Further movement widened the gull and the floor debris settled, leaving occasional calcited remnants still attached to the walls and massive, boulder-sized flowstone blocks littering the floor. A piece of this false floor has been collected for radiometric dating, which could prove a useful test for the Wolstonian age suggested for the main phase of mass movement in this area (Chandler *et al.,* 1976).

Sally's Rift appears to have formed as a result of mass movement between two bedding planes. One is the boundary with the underlying Fuller's Earth clays, the other is within the limestone sequence at the level of the entrance.

As a result of the extensive mining underneath the gulls of Henry's Hole a separate structural survey has had to be drawn (FIG. 5). This shows most of the major joints and gulls, except in Second Chamber where mining and subsequent breakdown have been the most extensive. Information here is more limited. The survey of Sally's Rift clearly shows the structure of the cave. Polar analyses, divided into 10° sectors (FIGS. 6 and 7) show joints as a simple numerical total but measure gulls as a sum of their lengths in any given direction. Despite some variations, none very large, only two main directions of jointing appear, NW/SE and NE/SW. The result is the same for both caves. This contrasts with the jointing directions seen in the Cotswolds (Hancock, 1969), where N/S and E/W joints are also developed.

The sum of the lengths of the gulls is a crude device to find the overall direction of mass movement. The sum of the volumes, taking account of the widths of the gulls, would perhaps be more accurate. This minor quibble

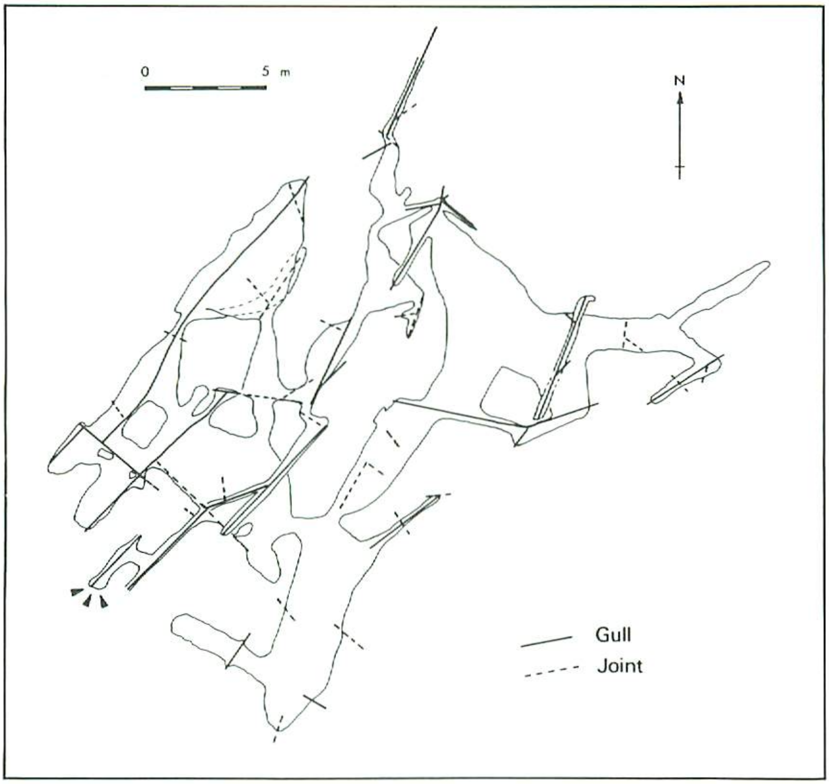

FIG. 5 — STRUCTURAL GEOLOGY OF HENRY'S HOLE

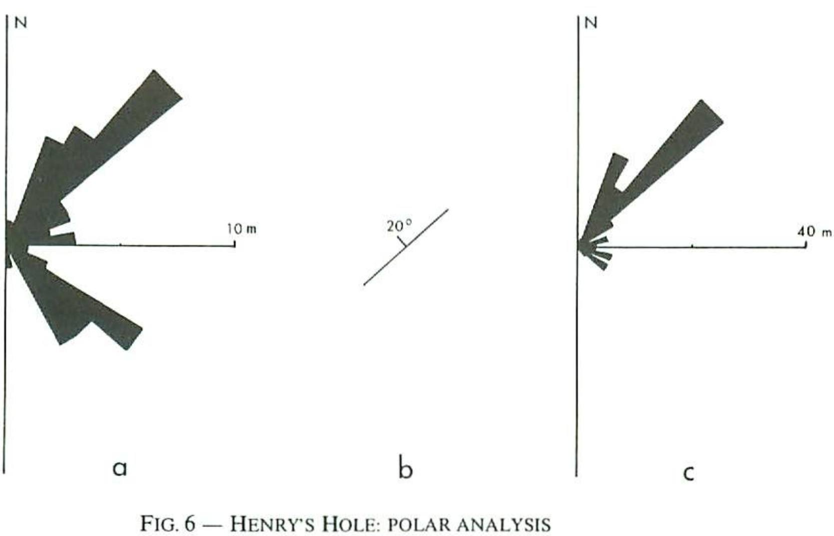

FIG. 6 — HENRY'S HOLE: POLAR ANALYSIS
a JOINTING: NUMBER OF JOINTS
b HILLSIDE: DIRECTION AND STEEPNESS OF SLOPE
c GULLS: TOTAL LENGTH IN METRES

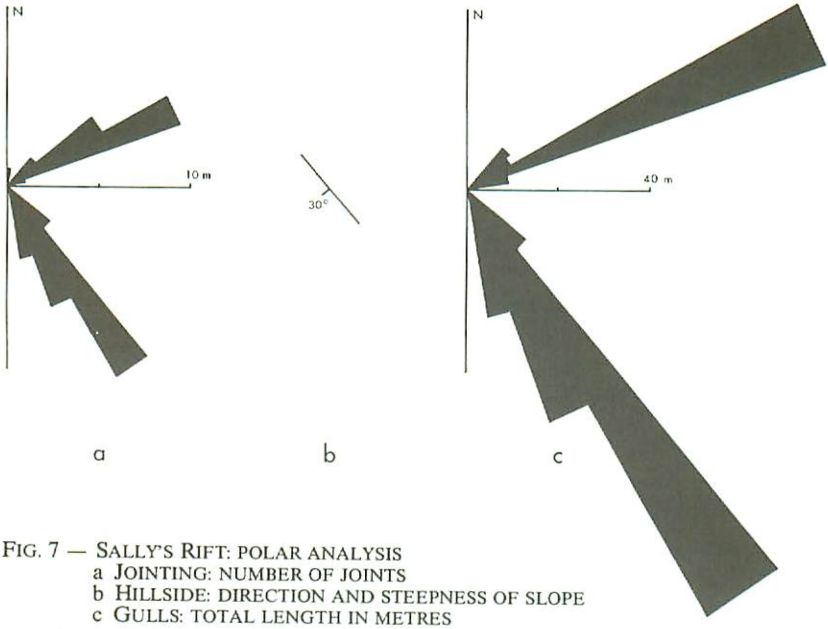

FIG. 7 — SALLY'S RIFT: POLAR ANALYSIS
a JOINTING: NUMBER OF JOINTS
b HILLSIDE: DIRECTION AND STEEPNESS OF SLOPE
c GULLS: TOTAL LENGTH IN METRES

aside, the vector sum of the gull lengths should give a direction parallel to the contours. For Henry's Hole this is clearly so, for one of the jointing directions (NE/SW) is closely aligned to the contours and has been preferentially developed, the gulls mostly running parallel to one another or *en echelon.* At Sally's Rift the contours also appear to be closely aligned to one of the jointing directions (NW/SE), yet the cross joints have opened to form a gull network. There is no evidence to suggest that the contours have significantly changed since the valley formed yet the polar analysis implies that the nett direction of movement was to the west.* A possible explanation is that Sally's Rift lies very close (within 100 m) to where the valley turns to the north. The rocks in which the cave developed must have moved as a part of the more northerly block and not in the local direction of slope.

As so many gulls become narrower with height it is not possible to calculate with any accuracy the degree of extension suffered by the cambered strata. Approximate values, based on gull widths at floor level, are: Henry's Hole, 10%; and Sally's Rift, 20%.

* Directions of movement are measured at right angles to the directions of gulling and so comprise a major component to the south-west, a smaller component to the north-west and minor components to the west-south-west and other directions. A summation of these vectors gives a direction two degrees north of west.

PLATE 1 — HENRY'S HOLE: THE STONE LINTEL IN SECOND CHAMBER.
Phot.: A. N. Patrick

PLATE 2 — SALLY'S RIFT: MAIN RIFT - AN INCLINED GULL WITH HUGE CHOCKSTONES.
Phot.: A. Boycott

PLATE 3 — SALLY'S RIFT: FAR RIFT, WITH A CALCITE-COVERED FALSE FLOOR REMNANT ON THE RIGHT.
Phot.: A. Boycott

PLATE 4 — SALLY'S RIFT: NE/SW RIFT JUST BEYOND COFFIN-SHAPED SLAB, SHOWING A DISTINCTIVE FIT FEATURE AT SHOULDER HEIGHT

Phot.: A. Boycott

PLATE 5 — SALLY'S RIFT: A BEDDING CAVITY (TYPE E IN FIG. 8), CLOSE TO THE SOUTHERN ENTRANCE

Phot.: A. N. Patrick

CHARACTERISTICS OF GULL CAVES

Many mass movement caves have been recorded in the caving literature (documented in Cooper, 1983) but the emphasis has always been on description of the caves themselves. Apart from Cooper's work, little effort seems to have been made to list the distinguishing features of gulls as opposed to solutional caves. Hopefully this paper will help the process of identification, but it should be borne in mind that gull caves subsequently invaded by streams will also show solution features.

Rifts formed by mass movement are very different in appearance to those formed by solution. Most obvious is the complete absence of solutional features. Where gulls can be seen to have flat roofs, the phreatic roof tube above the rift is notably absent. Unfortunately gulls are sometimes bouldery at roof level, while others become very narrow with height. Passage intersections also provide a way to distinguish between a gull and a solution rift. Gull rifts often end abruptly at cross-joints with no continuation possible for anything larger than a spider; a new gull will begin *en echelon*. This occurs when the rift direction is closely aligned to the contours. If the cross-joints also expand as a result of mass movement, to give a trellis pattern of gulls, the cave may look like a joint-controlled phreatic network. The distinguishing feature is in the occasional arm that does not open. Flowing water characteristically dissolves a pocket in the closed joint, which remains tightly closed at the back of the pocket. Mass movement leaves a very narrow, parallel-sided, open crack.

Solutional caves are often symmetrical in cross-section, less soluble beds protruding from both walls of the passage. Gull caves are asymmetric in a very precise way: a bulge on the wall of a gull is matched by a corresponding depression on the opposite wall. These 'fit features', as they are called, sometimes take the form of a bedding plane step, a flat ledge on one wall matching the flat roof of an overhang on the other (PLATE 4). In extreme cases (reported by Cooper) the passage may be divided horizontally at a bedding plane into two gulls, offset and at different levels. Structurally they are both part of the same passage, but the floor of one gull is at the level of the roof of the other and no physical connection is possible except at junctions with other joints. Bedding plane steps are rare in the mass movement caves that have been seen by the author. The presence or absence of steps depends entirely on the nature of the jointing. If a single joint joins the two planes of sliding there will be no step. If two joints in different beds are parallel and close to each other, a stepped gull may form, the two offset minor joints effectively becoming a single major joint. If there is no such line of weakness then a gull cave cannot form.

Two main factors control the passage network of gull caves. One is the topography, which determines the overall direction of movement. The other is the number and directions of the sets of joints. In the North Yorkshire windypits, which have received the greatest amount of study of all British gull caves (Cooper, 1983), the cave surveys show gulling in four directions (N/S, E/W, NE/SW, NW/SE). These gulls change direction at abrupt 45° corners and the typical windypit is an irregular spidery branchwork of passages. By comparison, Sally's Rift is constrained to two sets of joints (NW/SE and NE/SW) and so forms a regular rectilinear pattern. The extra sets of joints contribute to the notorious instability of the windypits, while the stability of Sally's Rift allows penetration deep into the hillside. In some rock types, such as Millstone Grit, joints can be curved rather than straight. This is an exception to the general rule that gull caves proceed in straight lines broken by abrupt corners where a new joint is followed. Gulls do not usually vary in width along their course and such variations are usually abrupt and bounded by cross joints. If there is rotation of an individual block of rock it is usually in the vertical plane and associated with cambering.

The floor debris in gull caves is also distinctive, being unsorted as it has never been washed by streams. Particles of mud and silt are often to be found resting on ledges, which are never clean, while at the opposite end of the scale boulders are commonly wedged across the passages. Speleothems may be formed if there is sufficient lime in the percolating water and, rarely, calcite deposits may seal the floor of a rift, leaving standing pools of water (Cooper, 1983). Moonmilk also is commonly found in mass movement caves.

A SYSTEM OF CLASSIFICATION FOR GULLS

As a result of studies made on a building site at Radstock, Avon, a system of classification (Classes I to IV) was devised for near-surface and surface gulls (Hawkins and Privett, 1981). This system was meant to assist building surveyors, therefore emphasis was put on the type and extent of infilling within the gulls. In the same study, Hawkins and Privett identified three types of mass movement (A-, B- and C-Type) and used this to demonstrate a new model of gull development, termed bed-over-bed sliding. This is now widely accepted as an explanation of these features. Although A-, B- and C-Type movements explain the vast majority of gulls there are features in both Henry's Hole and Sally's Rift that cannot be covered by so simple a scheme. Using the bed-over-bed sliding model, two further movements (D- and E-) are now added. Two obvious hybrid movements (AB- and AC-) complete this system of classification.

A detailed description of these movements now follows (see FIG. 8), combining the observations of the author, Hawkins and Privett (1981), and Cooper (1983):

A-Type movement results from the opening of a single major joint to create a straight, parallel-sided gull. The base of the gull is a slip-plane, the top is the ground surface. This type of gull is usually full of surface-derived debris, though in areas of active erosion such as near waterfalls or cliffs it may remain open. Rock labyrinths are of this type.

B-Type movement comprises extension over a broad zone. Bed-over-bed movement has taken place at many levels to produce a large number of small voids. It is not important whether one bed has moved overall further than any other bed, for the characteristic of B-Type movement is the opening of minor joints to create gaps in the bedding, rather than major joints to form A-Type gulls. Normally the cavities in

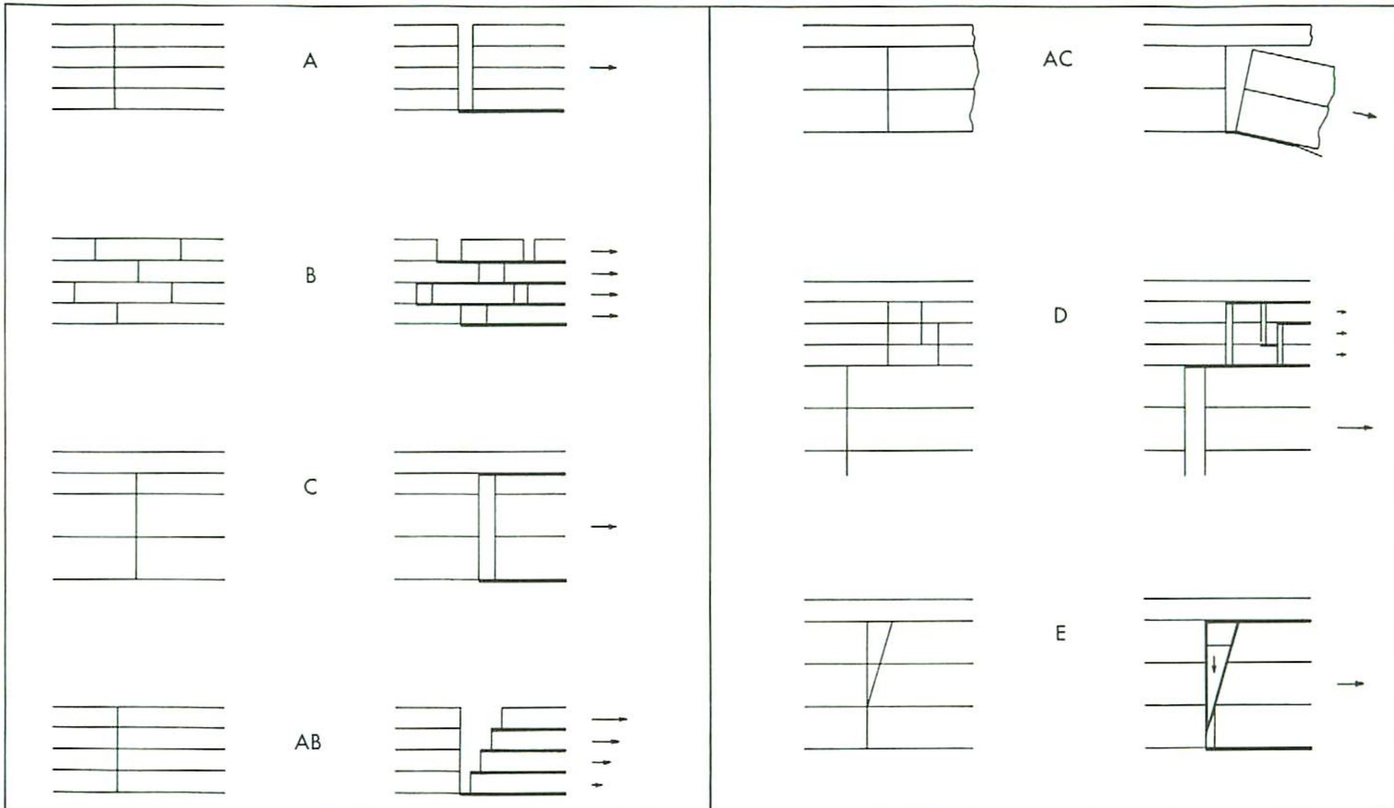

FIG. 8 — A MORPHOLOGICAL CLASSIFICATION OF GULLS. BOLD LINES DENOTE PLANES OF MOVEMENT. FOR EXPLANATION SEE TEXT.

the uppermost beds are filled with debris of surface origin, though voids may exist at depth.

C-Type movement is described by Hawkins as A-Type movement at depth. A large cavity is formed by the opening of a major joint, but bedding plane sliding along a prominent upper horizon results in an almost undisturbed roof. If this upper horizon is shallow, however, some movement may be taken up in the surface zone. This type of movement typifies the deep gulls that are found on cambered hillsides. Whilst the gulls are often parallel-sided, gulls which taper towards one or other of the sliding planes have been reported (Tucker, 1965a). The lower sliding plane is always obscured by material fallen from the roof. In some cases fallen boulders become wedged across the gull and a false floor of boulders may develop. Flowstone on the walls is quite common, becoming purer in colour in the deeper gulls where there is less addition of surface debris.

AB-Type movement is a hybrid type combining a major joint between ground surface and the bottom plane of movement with bed-over-bed sliding at all levels. The closest mundane analogy is a spilt pack of cards, where each card slides relative to the one beneath it, the top card moving furthest of all. Movement must have taken place in a very well-lubricated environment and equally important is the presence of slippage planes, perhaps thin partings of clay or shale, between the sliding beds. Gulls of this type were seen at Radstock, but were not separately classified. They are usually infilled, though voids may exist at depth.

AC-Type is another hybrid movement where a gull has a roof but this roof is unsupported on the downslope side. This type of gull occurs in very active systems, such as sea cliffs, where the base of the moving block has been undermined or the underlying beds have foundered. The surface beds are not affected by the moving block, which slides out from beneath the parting layer to leave both a gull and a bedding plane cavity. Due to the unsupported roof, these features are likely to be short-lived.

D-Type movement has not been recognized before and has been devised to explain the extension cracks of irregular depth in such caves as Henry's Hole. In theory, if major C-Type movement develops at depth secondary gulling may occur above the upper sliding plane. The main moving block catches on the bed above and drags open some joints in the near-surface zone. Both major and minor joints may be affected and several new planes of slippage are created. The absence of a recognizable single plane of slippage, at either the top or the bottom of a group of gulls, is indicative of D-Type movement, particularly if there is a known plane of slippage at depth.

E-Type movement is a variation of C-Type movement whereby two joints that follow the same direction but at an angle to each other in the vertical plane, join at depth above the level of the lower sliding plane. As mass movement occurs, the block of rock between these two joints becomes unsupported and subsides to leave a bedding gap beneath the upper sliding plane. Bedding gaps have been seen in Sally's Rift (PLATE 5) where most, but not all, joints are vertical.

THE MECHANICS OF GULLING

Gulling occurs when a mechanically strong rock is subjected to extension along the bedding. A slightly narrower definition is given by Thomas (1981) who describes gulls as tension cracks associated with cambering. These cracks are already present in the rocks as joints, so gulls always follow the jointing directions. If gulling were the result of mechanical failure of the rock there would be a quite different pattern of fractures relating to the direction of mass movement. Movement is always by gravitational sliding and occurs only where there is a natural void into which the sliding mass may move. A typical situation is on a steep hillside or valley side, though other locations have been described (Cooper, 1983). Movement also requires an underlying layer of an incompetent material such as clay, silt, or shale. This is illustrated in FIG. 2, which shows a typical section through a cambered hillside. The competent material in this instance is limestone and also shown is the weathered, thinly-bedded zone near the surface which makes such a poor roof to the gulls. For this reason hillslope gulls are often filled by surface-derived material and accessible gull caves are rare.

In the Bath area, competent and permeable well-jointed limestones overlie incompetent and impermeable clays. In such a situation groundwater passing through the permeable strata frequently causes some erosion of the underlying sediments (Hawkins, 1980), a process known as underleaching. The result is that in hillslope regions the more competent horizons lose their support and form drape structures. Movement is taken up within the jointing and gulls develop. Thomas (pers. comm.) suggests that this erosion takes place immediately after a periglacial cold phase when warming of the frozen ground is still incomplete. Groundwater passing down joints in the limestone softens the top few metres of the underlying clays which ooze out from the hillside due to overburden of the limestone pressing down on a frozen clay base. Cambering takes place only for a short period of time, for when the ground is fully thawed rotational slides take place within the clays. These rotational slides are younger than the cambering and may undermine and remove the cambered drape slope. For this reason, well-drained promontaries and up-dip scarp faces may prove the best locations for gull caves, since better lubricated sites are more likely to have suffered landslip. A quite different viewpoint is that north-facing slopes undergo less melting in a periglacial environment and so are generally steeper, the better to preserve relict features such as gulls. In some cases, actively eroding south-facing slopes may not have cambered at all. Which of these factors is the more important, groundwater drainage down-dip or solar warming, is open to debate. Henry's Hole and Sally's Rift are not helpful examples, for the former is on a north-west facing slope and the latter on a slight south-west facing promontary, the regional dip being to the east-south-east.

One of the main objections to the theory of gravitational sliding as a mechanism to form gulls is that the local dip in the direction of movement is often very slight. If percolating water were merely a lubricant this would be a valid point. However, with plastic flow within the clays there is no frictional resistance at the lithological boundary so any valleyward dip, however slight, will result in movement of the overlying rocks. Frictional resistance at the upper sliding plane is another matter and the mechanism by which gull caves form is not properly understood. In the shallow gull caves studied by Hawkins and Privett (1981), part of the gull movement was transferred to minor joints in the surface beds to produce a broad extension zone of fractured blocks. In Henry's Hole, where major gulling at depth is suspected, this transfer takes the form of irregular secondary D-Type gulling. In these cases movement can be identified in the beds above a gull, though it often seems much less than in the gull itself. In Sally's Rift there appears to be a preferential horizon, perhaps a clay parting, that forms a common upper boundary to the gull disturbance. In a well-lubricated environment one would expect the overlying rocks to slide downhill on such a plane, but the evidence from Sally's Rift suggests exactly the opposite. The overlying rocks are not appreciably disturbed and movement occurred beneath this upper sliding plane. It may be that there are fewer major joints in these upper beds, causing greater interlocking of the strata. Another effect of such structural strength would be to delay cambering. When cambering begins, gulls develop between the blocks sinking and sliding at the lower plane in the plastic flow of the clays. If this cambering is not immediately and uniformly transferred up through the strata there may be partial unweighting of individual blocks beneath the upper plane. This would greatly reduce friction against these upper beds and in favourable situations the drag against them would be insufficient to prevent movement. In this way, mass movement can be confined between a lower sliding plane and an upper parting/sliding plane. The above explanation is necessarily over-simplified, but it may help resolve the most obvious weakness of the bed-over-bed sliding model for gull development.

A method that provides a roof to an A-Type gull (suggested by Cooper *et al.,* 1982), by trapping surface debris above a boulder false floor, seems unlikely and has not been seen by the author. Bedding plane steps large enough to span a gull and give a solid roof have not been seen, either.

Cambering is normally a regional phenomenon but small-scale cambering can sometimes form gulls. Perhaps the commonest occur just behind the tops of cliffs where 'toppling blocks' of the cliff edge create gulls that are wide at the top and narrow at the base. Usually, toppling block gulls are simple open cracks and occur in massive homogeneous rocks. They differ from A- and AC-Type gulls in that there is no basal sliding. Sliding without rotational cambering can produce gulls, usually A-Type, in strata that have been undercut in the down-dip direction. The dip is normally much more pronounced than in cambered hillsides. Other forms of mass movement include cave-like cavities formed in a settling scree slope (described in Cooper, 1983), cracks formed by earthquakes and glacier crevasses. It is not proposed to call these fractures gulls.

Although gravitational sliding is used in this paper to explain gulling, other mechanisms have been proposed (documented in Cooper, 1983). Of these, earthquakes producing gull caves need not be seriously considered, but frost wedging deserves comment. The process as described is ice wedge formation within a joint and has a number of enthusiastic supporters. The idea is certainly attractive, with the 9% increase in volume of water when it freezes, but it has a serious flaw. In regions of permafrost the active layer (that is, the region near the surface where frozen ground melts in the summer) is always very shallow. It is usually within the range 30-100 cm, though a maximum of 5 m may be attained if there is no vegetation cover (Sugden, 1982). Ice wedging is therefore seen to be a superficial process, affecting only a shallow region near the surface and could only explain gulls whose slip plane is not too deep. A cave such as Sally's Rift has gulls whose roofs are 25 m below the present ground surface, the slip plane being another 15 m or more deeper. Not only would ice wedging not occur, but at this depth the cave is below the zone of annual temperature variation.* Seasonal freezing of the ground without permafrost is a similarly shallow phenomenon.

CAVE FAUNA

Both Henry's Hole and Sally's Rift support large populations of fat brown spiders (*Meta menardi*), notably the entrance passages of Henry's Hole, but all the spiders, woodlice, moths and gnats seen underground are surface forms. No cave-adapted species has been identified.

Sally's Rift is an important retreat for the Greater Horseshoe Bat (*Rhinolophus ferrum-equinum*), and occasional bats (species not identified) have been seen in Henry's Hole. Visitors to these sites should avoid the winter months (December to March) when the bats are hibernating.

ACKNOWLEDGEMENTS

I would like to thank A. Boycott, I. G. Butterfield, E. Lloyd, M. McHale, G. J. Mullan, A. N. Patrick, J. T. Whicher, J. W. Whicher and L. J. Wilson for help during the exploration and survey of these caves. Without the assistance of Chris Batstone the report on Sally's Rift would have been embarrassingly incomplete. For technical advice I am indebted to P. R. J. Chapman, P. L. Hancock, A. B. Hawkins, A. Philpott, E. A. Price P. L. Smart and G. G. Thomas.

Many thanks to Ted and Alison Lloyd for cups of tea and a warm kitchen to change inside, when visiting Henry's Hole.

* The amplitude of seasonal variations of temperature is greatest near the surface, but falls off exponentially with depth. Depending on the type of ground, seasonal variations become negligible at a depth of between 6 and 25 m. The ground temperature stays the same as the mean annual air temperature, plus a contribution from the geothermal gradient (usually 1°C for each 50 m depth gained).

REFERENCES

ANON. 1895. Bath Stone. *Builder,* **68** (2723), Apr. 13: 273-278; (2724), Apr. 20: 291-295.

BARRINGTON, N. and STANTON, W. I. 1977. *Mendip: the complete caves.* Cheddar Valley Press, Cheddar.

BATSTONE, C. 1985. Pers. comm.

CHANDLER, R. J., KELLAWAY, G. A., SKEMPTON, A. W. and WYATT, R. J. 1976. Valley slope sections in Jurassic strata near Bath, Somerset. *Phil. Trans. R. Soc. London., A.* **283**: 527-556.

COOPER, R. G., RYDER, P. F. and SOLMAN, K. R. 1982. The Windypits in Duncombe Park, Helmsley, North Yorkshire. *Trans. Brit. Cave Res. Assoc.* **9** (1): 1-14.

COOPER, R. G. 1983. Mass movement caves in Great Britain. *Stud. Speleol.* **4**: 37-44.

HANCOCK, P. L. 1969. Jointing in the Jurassic limestones of the Cotswold Hills. *Proc. Geol. Ass.* **80**, 219-241.

HAWKINS, A. B. 1980. Geology and its implications for the municipal building surveyor. *Municipal Building Surveyors Annual Conf. and Symp., Bath, 1980.*

HAWKINS, A. B. and PRIVETT, K. D. 1981. A Building site on cambered ground at Radstock, Avon. *Q. J. Eng. Geol. Lond.* **14**: 151-167.

PRICE, E. A. 1984. *Bath freestone workings.* The Resurgence Press, Radstock.

SPARROW, A. 1983. Henry's Hole. *Belfry Bull.* **37** (1) no. 417: 2.

SUGDEN, D. 1982. *Arctic and Antarctic.* Blackwell, Oxford.

THOMAS, G. G. 1981. The Engineering geology of selected Fuller's Earth hillslopes in the south Cotswolds. Unpublished M.Sc. thesis, Univ. Bristol.

THOMAS, G. G. 1985. Pers. comm.

TUCKER, J. H. 1964. Gully Wood Cave No. 3, Monkton Farleigh, nr. Bath. *Axbridge Caving Grp. Archaeol. Soc. Newsletter,* Nov.: 104.

TUCKER, J. H. 1965a. Caves in the Jurassic Limestone outcrop of the north-west Wiltshire/north-east Somerset border area. *J. Axbridge Caving Grp. Archaeol. Soc.,* for 1964: 10-23.

TUCKER, J. H. 1965b. Further work at Gully Wood. *Axbridge Caving Grp. Archaeol. Soc., Newsletter,* May: 32-33.

C. A. SELF, 4, Tyne Street, Bristol BS2 9UA, U.K.