

# White Scar Cave, Ingleton

Tony Waltham

White Scar Cave lies less than two miles northeast of Ingleton village in the county of North Yorkshire. It is cut in the Lower Carboniferous Great Scar Limestone beneath the western flank of Ingleborough and opens into the side of Chapel-le-Dale. Both entrances are only a short distance from the B6255 road up Chapel-le-Dale and are not difficult to find as White Scar has been a popular show cave for many years. The cave takes its name from the very conspicuous White Scars – the glaciated scars of limestone which overlook the entrance and the valley. White Scar cave is a resurgence system which carries water northwestwards from Crina Bottom and also collects all the percolation drainage from the White Scars and Lead Mine Moss limestone bench. The cave is therefore unique in Yorkshire, in that it is a major stream cave which can be entered from its resurgence. Furthermore, it is a very spectacular, thoroughly enjoyable and scientifically most instructive cave.

## History of Exploration

Christopher Long, a Cambridge undergraduate, discovered White Scar Cave in 1923 when he spotted a likely looking entrance from a vantage point across the Dale on Scales Moor. The passage he explored was a miserable crawl in a stream with boulders and cold pools; it was 700 feet long and no longer exists since it was blasted out to accommodate the show cave entrance passage. The crawl led Long to the streamway at the foot of First Waterfall and from there he explored upstream – a magnificent feat considering his totally inadequate equipment, highlighted by short trousers and candles stuck on his hat for illumination. Long swam across First Lake but was then stopped by Long Stop Lake; this was later crossed on rafts made of oil-drums and timber, and the great boulder choke of Big Bertha (strictly the name of the first, massive boulder) was reached.

The next ten years saw progress in two spheres. The show cave was opened by blasting out the entrance crawl and placing plank walkways in the stream cave as far as the Barrier.

Meanwhile Tom Greenwood eventually engineered the very complex route through the Big Bertha choke, and the Far Streamway was open. With Colonel Swift, Eli Simpson and other members of the British Speleological Association, this was explored as far as the canal underneath the Hall of Justice, where the deep, cold water so far from daylight was too great an obstacle at that time. They had already had an epic series of trips to build rafts to cross Swift's Lake which is, however, only waist deep. The same team also explored the first part of Moonmilk Inlet and climbed up into Carrot Hall without finding the way on. After World War II, exploration was severely curtailed by the show cave owners. A few trips were permitted however, and members of the Craven Pothole Club, among others, explored as far as the first wet section, near Gem Inlet, in the Phreatic Series.

A second phase of exploration opened in 1967 when John Southworth, of the Happy Wanderers Cave and Pothole Club, explored the very cold and aqueous passages in from the active resurgence to the show cave. This fine piece of caving opened the way for a series of unofficial trips into the cave, always at night, using the wet entrance whenever the water was low enough to permit access. The Wanderers explored the rest of the Phreatic Series then dived the first two short sumps to discover the canal passages as far as Sump Three. In 1970, Alf Latham, again on a night trip, found the climb up into the Hall of Justice and he and other members of the University of Leeds Speleological Association then explored the Sleepwalker Series as far as Sump One. The next year, John Russom and more Wanderers dug a way upwards through the Big Bertha Choke and discovered the enormous Battlefield Chamber, and also explored the Western Front and Northern Line. Second Front was discovered later in stages, first by the Northern Cave Club and then finished off by Leeds University Speleological Association. The interest in White Scar at the time prompted the opening up of the Greenwood Pots, the major sinks for the cave. Greenwood Two fell to blasting by the Wanderers and the main stream was followed to a depth of 175 feet, but the way down to White Scar is hopelessly blocked. Greenwood Three was opened up by Leeds University Speleological Association but is not as deep as Two.

In 1975, White Scar Cave was sold and the new owner has adopted a very generous attitude of encouraging exploration and work in the cave. Unfortunately though, discoveries have not been as spectacular as in previous years. In the main stream, Sump Three was passed in 1975 by Geoff Yeadon and Oliver "Bear" Statham, who had previously dived part of it on a phantom night trip. In 1976, they returned with Phil Pappard and pushed Sump Four until it was dangerously constricted. In Sleepwalker, Alf Latham passed Sump One and later Rob Palmer dived Sump Two until it became ridiculous to proceed. The choke in Moonmilk Inlet was blasted three times by Clive Westlake to reveal an extension to another more solid choke. Various people, on parties led by Julian Barker, Ric Halliwell or the writer, have then found Gem Inlet, the two Roof Series in Far Streamway and Sleepcrawler, and the Leeds University cavers climbed Strategy Aven in the Battlefield. Other maypoling projects have so far been essentially fruitless.

Since the 1975 change of ownership, the main work in the cave has been directed into various scientific studies. The whole cave was resurveyed (see enclosed fold-out plan) by the writer and numerous friends. This was an essential step towards further geomorphological and geological studies, for the cave's development is most instructive in the field of speleogenesis. At the same time a major water sampling programme was carried out by Ric Halliwell. While some preliminary comments on the hydrology and geomorphology of the cave follow below, the main results will be written up in a series of papers which will appear in future.

## Description

### The Streamway

The Water Exit has been blessed with a brick blockhouse connected with the diversion of water into a couple of reservoirs, so now the only way into the cave is through a very narrow drain. Once in rock, the passage continues as low and wet joint-oriented crawls with limestone roof and walls but a floor of the Ingletonian slate. Only in very dry weather is there not a sump within 50 feet of daylight. Various side passages are choked, but some must connect to the flood risings to the north. The last wet bit is in a bedding plane with a duck 57 feet long which is discouraging for the hydrophobic in anything but extreme drought. Stooping passages continue to the First Waterfall where a gate is now installed. Leaving from the south side of the waterfall chamber is the show cave entrance passage, originally a miserable bedding plane crawl. Upstream and beyond a grovel beneath a flowstone bank (bypassed by a mined tunnel) the passage is a stooping height canyon to Second Waterfall. Here the roof rises to over 20 feet and an inlet enters from a choked bedding passage in the roof. The First Potholes are now buried beneath the planking of the show cave path and the canyon continues with comfortable dimensions, finely decorated with stalagmites and large flowstone banks. The Grotto is a phreatic roof rift impassable after a few yards.

The Main Streamway continues as a roomy, flat-roofed canyon with a scattering of stalagmites and a few fine calcite cascades. None of the inlets can be followed far. First Lake is a short wade, barely waist deep, and Long Stop Lake is just beyond. Both lakes are partially held back by debris piles from avens, but there is certainly over-deepening of the floor in Long Stop Lake. The water depth in this one is up to seven feet, but its whole 260 feet length can be traversed on underwater ledges, which are all on the outsides of the bends. With a little sporting effort, the caver need not get wet above his waist. The Big Bertha choke, at the end of the lake,



*Main Streamway before First Lake.*



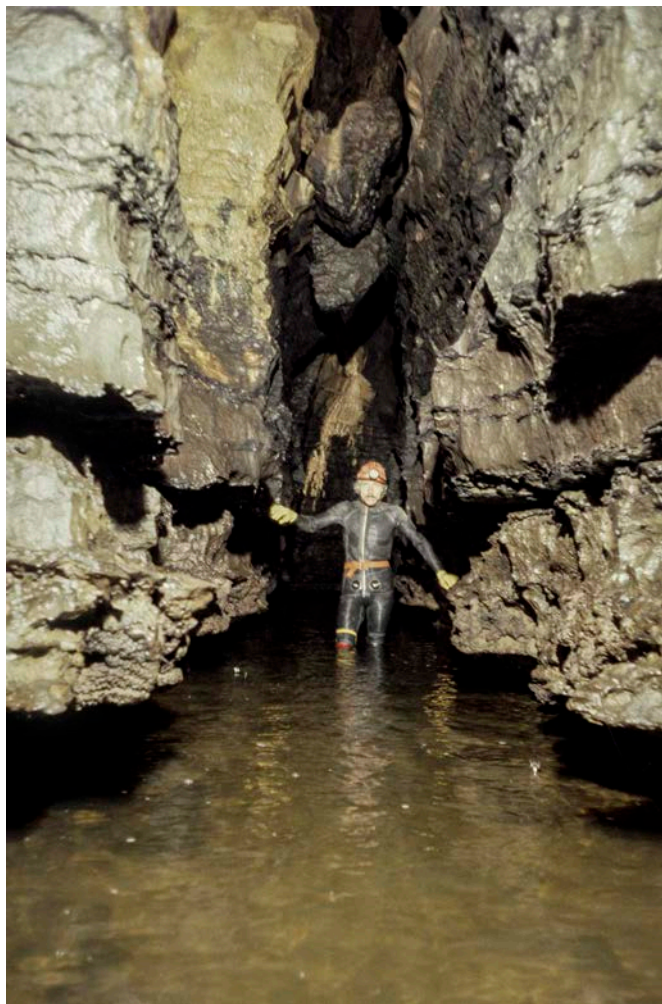
*Grit Falls, the only exposure of the basement rock.*

is traversed by a tortuous route mostly at stream level. One low bit is a duck in wet weather, and just beyond it an upward squeeze was called Coat-Off Squeeze by Tom Greenwood. However, the boulders moved here in 1976 and it must now be avoided by a very low duck and tight squeeze on the left. The constrictions in the choke can cause water to back up in very light flooding, and exit from the cave then becomes impossible. Beyond the choke, the Far Streamway continues as a roomy canyon. Moonmilk Inlet is a canyon entering on a shelf eight feet up on the left. Its floor of soft calcite soon changes to boulders and the roof lowers into the constrictions of the Blasted Choke. After three squeezes and a canal, a high canyon with some narrow upper levels continues to a large, unpenetrated choke.



*Flowstone in Main Streamway.*





*Far Streamway, beyond the Big Bertha choke.*

Back in Far Streamway, the canyon continues. Grit falls is a waterfall nearly twelve inches high, but it deserves its name because its lip is cut into Ingletonian grit – the only place where the basement rocks are seen in the upstream cave. Second Potholes are only shallow and above them the roof rises into a narrow joint. By the Oxbow, the canyon is an impressive 35 feet high and it continues as high, partly well-decorated, right up to the Tunnel. Swift's Lake is only waist deep and ends in a spectacular black rift leading to the Third Potholes, some of which are almost waist deep. The Tunnel passes under a boulder pile and, a few yards ahead, an obvious climb on the left wall leads up into a 15 feet diameter tube in the roof of the canyon. Downstream this leads to Carrot Hall, named after its red stalactites, with a slot in the floor down to the streamway; there is then a climb up over boulders to roof rifts beyond which the phreatic route cannot be followed because of a very solid fill. Upstream of Carrot Hall the high level route involves a delicate mud traverse and then wider ledges to the Hall of Justice. Down below, the canyon has beautiful wide ledges as far as the Canal, where a huge mass of boulders (below the Hall of Justice) rests on the ledges. Water level is four feet below the ledges and the Canal is the only way on in the floor's narrow trench – as a sporting traverse, a wade for some (it's up to six feet deep), or a swim.

Beyond the Canal, the wide ledges continue along the Traverses. A small phreatic tube can be followed 20 feet up in the roof. A boulder pile in a chamber at the end of the Traverses is overlooked by a hole high in the roof – this requires

maypoles to reach the Roof Series. On the sharp left hand bend in the streamway, there is a climb on the right to a short series of tubes, and a harder climb on the left up to a boulder slope which leads into the high, decorated rifts in the Roof Series, all of which are choked. The streamway continues as a classic keyhole passage, and an obvious muddy slot on the left provides a greasy route up into Straw Chamber. The straws are up to six feet long, beautifully white and in a corner safely out of the way of all but the intentional vandal. Further upstream, the water cascades into a deep pool, but the largest way on is up a dry boulder slope to the left into the high, phreatic rifts of the Great Rift. All ways on are unfortunately choked and the Inlet ends where it shrinks down to a tube only six inches in diameter.

The cascade in the streamway is a classical nick point situated at the end of the vadose canyon, for beyond it the passage is a fine phreatic tube about half full of water – the Phreatic Series. It is a thoroughly enjoyable, very sporting passage, with deep wading interrupted by a series of ducks with varying amounts of airspace. Gem Inlet enters on the left; it contains a boulder-choked aven back over the streamway, and a route on the left up three loose climbs to a choked rift. Phreatic Series ends in a small wet chamber from where Sump One leaves – eight feet long, shallow and without a line. Sump Two follows immediately, twelve feet long and deeper, beyond which Sump Series continues as more canals and tall rifts broken by ducks, the last one involving a short dive. Sump Three is 430 feet long and descends to 23 feet before rising into



*Traverse in Far Streamway.*





*Phreatic Series.*

the tall joint rifts of Taffy Turnip's Trepidation. These extend just over 100 feet to Sump Four which descends rapidly to a depth of 30 feet, and then continues as a meandering tube. Unfortunately the sump has a floor of fine, easily disturbed silt – hence the name Three Blind Mice – and exploration ceased where the space between silt and roof was intimidatingly small. This point is 8100 feet from the resurgence, yet still is at 300 feet depth beneath Crina Bottom.

### **Battlefield Series**

A climb onto the top of the Big Bertha boulder and then upwards through the boulder choke leads to a body-sized hole known as the Foxhole. Above it is blackness, for it opens right into the middle of the floor of the Battlefield Chamber, 300 feet long, 60 feet wide and 30 feet high. The floor is a chaos of mud-covered boulders rising to a massive pile at the northern end. Some fine straws, numerous mud formations and some large stalagmite banks break the gloom of the chamber. Avens soar into the roof, the highest being Strategy Aven requiring maypoles and then a long climb in a rift. From the southern end, Western Front is a long tunnel containing an over-abundant share of sediment and collapse. Some of

the passage is walking height, while much is for crawling only. Short stalagmites decorate the first section, an enlarged section midway contains a magnificent display of straws and the end chambers contain large dried out gour pools cut into a mud floor overlooked by hundreds of straws. The whole of Western Front is fragile and will undoubtedly suffer if many casual visitors travel it.

From the northern end of the Battlefield two passages continue. The obvious way round the left (west) side of the collapse pile leads to the Northern Line. This is a tall canyon



*Northern Line.*



*Part of the Battlefield chamber.*

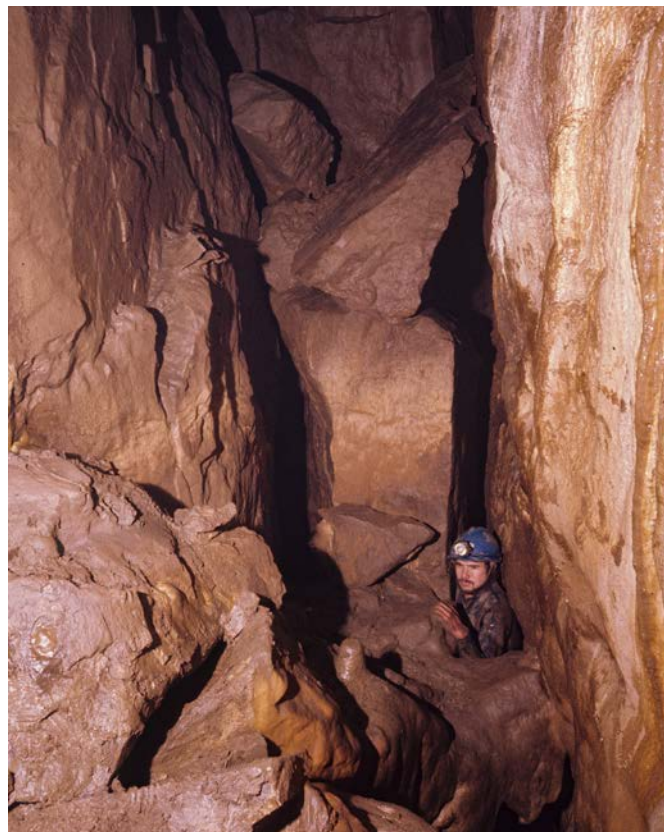


passage with phreatic roof features and a floor of deep mud. It ends at a massive set of flowstone banks, some fine roof decorations, and just beyond a pool, an impenetrable choke. Eastwards over the debris pile in the chamber leads to a descending route beneath a collapse roof. A tortuous route back up through boulders leads into the roof of a massive phreatic tube which is nearly blocked by large amounts of collapse. This is the Second Front, and it continues through a couple of narrow squeezes into more open chambers which end at a complex choke with water trickling down through it.

### **Sleepwalker Series**

The normal route into Sleepwalker is a spiralling climb up through the boulders at the end of the Canal in Far Streamway. Fifty feet above water level, the Hall of Justice is an enlargement in a massive phreatic tube. Downstream leads across a boulder floor and then traverses into Carrot Hall, above the streamway. Upstream in the tube is a spacious descent, past some fine red formations, into the Yard. Holes in the floor drop down into the Sleepwalker streamway blocked by boulders in both directions, downstream only a few yards from where the water pours through into the Canal. Hidden behind formations on the left of the Yard is a rift which continues as the Arm, tall and wide, but choked with boulders after less than 200 feet. The main route continues over and round boulder piles, still well above the stream, to a sandy floored high rift from where an obscure hole leads into Sleepcrawler. This is an obnoxious succession of muddy grovels broken by one tall aven.

The next section of Sleepwalker is through, over and under a series of boulder piles which are loose enough to ensure that the great majority of cavers who have been through it have vowed never to return. A few mild contortions and a silly little squeeze round to the left of a massive boulder lead to the top of a loose boulder slope back down to stream level. Ahead



*The Pincher, in Sleepwalker Series.*



*Whitehall Series.*

and up over more boulders lies Peel Hall with fine formations but unfortunately no other way out. The way on is therefore down to the water and along the Grommiter crawl then up beneath high rifts (which are within feet of Peel Hall) and into the spacious Crescent Hall. The passage turns here along the line of a major fault zone and the south wall of Crescent Hall is on the fracture line. At the end of the Hall the floor is prone to collapse but the way on is a traverse over large blocks and along another high rift to an almost complete choke. A hole down through this is the Pincher – a delicate 20 feet climb down a tapering rift with the promise of oblivion offered by a gaping black hole in the floor. The hole opens into the roof of the streamway, and the route on is over boulders to a climb down, where the key handhold fell off in 1976.

The streamway beyond is pleasant as far as Jailhouse Rock. This massive block stands at the junction of various high and low level rifts containing boulder piles which involve a few climbs and a short wet bit down in the stream. At Whitehall Junction the high rifts turn right over a boulder pile into the fossil passages of Whitehall Series. At the two right-hand bends, holes in the floor lead back to the streamway, the first to the roof and the second to the floor. The following left-hand bend has a fine cracked mud floor and various roof rift continuations. Just beyond, the Pit is choked 15 feet down, and a traverse across it leads to a boulder-strewn rift which gradually decreases in size and has many branches all of which are short. At the end the water emerges from a bedding plane above which an aven may be climbed for 70 feet to the highest point yet reached in the cave.

From Whitehall Junction the way back to the stream is a drop over boulders, and the route is then wide open. Various roof passages are easily climbed into, and eventually Beat Street develops into a fine keyhole passage, with some areas of good decorations. There is a wide bedding plane slot at floor level, and a roof tube which eventually offers the best way on where the canyon is nearly choked with boulders. Above the boulders Aven 49 soars into the darkness, and beyond it the old phreatic tunnel is almost canyonless. An old outlet on the right is full of glutinous mud and long straws but upstream is an easy walk as far as a sandbank beyond which lies a wide, shallow pool. This is the Final Sentence, a long wallow with decreasing airspace as far as Sump 1. The sump is 30 feet long, with joint guided airbells, but is deep and not free-

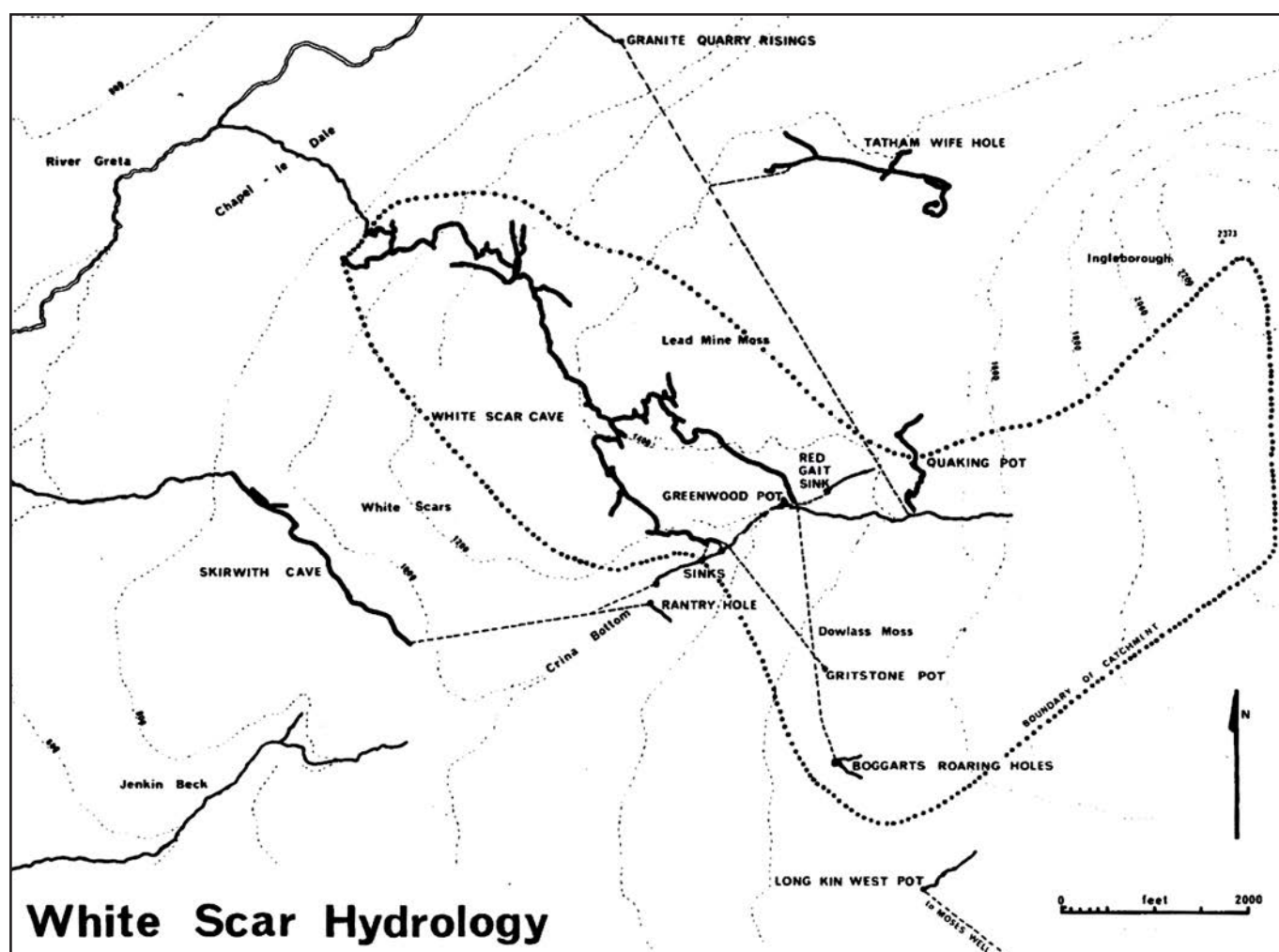
diveable. The passage beyond is a high rift which develops into a wet crawl over a gravel floor. At a junction, right leads to another rift and an aven carrying water down from Crina Bottom almost directly above. Left is the very Shallow Sump 2 in the continuing phreatic tube. It has been dived for 120 feet to where it is nearly blocked by collapse, at a point 7350 feet from resurgence.

## Hydrology

As it drains a significantly large portion of the western slopes of Ingleborough, White Scar Cave carries one of Yorkshire's larger underground streams. Its normal flow is a little under 2 cusecs, measured at First Waterfall, but in the very dry summer of 1976 a minimum of 0.1 cusec was recorded. The cave stream has a very fast response to flooding, rising shortly after heavy rain to give a high flood peak followed by an almost equally rapid decrease of flow. The highest recorded flow is 34 cusecs but that is when the cave is still safely accessible, and the not uncommon floods which fill the show cave to the roof must reach double that figure. Under the measured conditions, the main stream from Phreatic Series normally contributes about half the total flow, with a quarter coming from the Sleepwalker stream and the remaining quarter being contributed by the many roof inlets. The number of roof inlets varies with stage, but in reasonably wet conditions there are about 30 significant inlet showers along the main streamway. With a total flow of much over 5 cusecs the Big Bertha choke is impassable, so little is known of flood conditions in the far end of the cave. The one party that involuntarily spent the night watching a

flood peak in Far Streamway reported that many of the little roof inlets grew rapidly to sizeable cascades.

The main stream water is derived largely from Greenwood Pot and Red Gait Sink. Even though the large phreatic tube of Sump Series does not seem related to Greenwood or Red Gait, if it does have a source hidden under till, further up Crina Bottom, there can be little water coming down it. Water sinking at Gritstone Pot feeds the Sleepwalker stream, but the water from Boggarts Roaring Holes must cross this underground as it has been tested through to the Main Stream in White Scar. The two sinks in Crina Bottom, above the house, both feed into Sleepwalker – though it is not known just where in Sleepwalker the waters arrive (the links shown on the survey are only inspired guesses). Water disappearing in the lowest sink in Crina Bottom joins that from Rantry Hole and resurges at Skirwith Cave. The various Crina House sinks are only active in high stage conditions when they progressively receive overflow water from Greenwood Pot. Crina Bottom is therefore a superb example of a karstic valley which exhibits subterranean downdip leakage of its drainage along four parallel routes. In the upper end of the Crina Valley, water sinking at Quaking Pot flows to Granite Quarry Risings. The main stream sinks at Greenwood, feeding to White Scar, but overflow sinks at Crina House into Sleepwalker, and then into White Scar. Further overflow sinks to emerge at Skirwith while the surface valley continues down to Jenkin Beck. There are no other discrete sinks in the White Scar catchment, and the various minor inlets are all fed by percolation and seepage water from White Scars and Lead Mine Moss.





With Quaking Pot lying outside one boundary of the White Scar catchment, and Long Kin West (feeding to Moses Well) beyond the other, the catchment area can then be estimated at 1.15 square miles. The “normal” flow, taken as 1.8 cusecs, therefore accounts for about 35% of the precipitation which lands in the catchment. The remaining 65% of the precipitation must be accounted for by evapotranspiration (probably about 20% on average), flood flows, and high-stage overflow down Crina Bottom into the Skirwith catchment. Nearly half the water in the catchment is therefore transmitted in flood peaks – in a very “peaky” pattern typical of a mature karst.

## Geomorphology

On the general scale the geomorphology of White Scar Cave is very simple, as it has two main contrasting phases of development, in common with most other Yorkshire caves. A broad outline of the passage development is presented below. In detail, however, the cave is far more complicated and has much to offer the enquiring mind of the cave geomorphologist. The whole cave is developed in the lowest beds of the Great Scar Limestone, and yet only a very small proportion is actually on the limestone base — which is an unconformity on Ingletonian (Ordovician) slates and greywackes (grits). Most of the passages originated on relatively minor lithological variations some distance above the unconformity, and the subtleties of geological control, both structural and lithological, are probably demonstrated better in White Scar than in any other Yorkshire cave. Furthermore the various phreatic passages in the cave show some rather unpredictable irregularities which again may have some fundamental geological control. These geological and geomorphological problems are the subjects of continuing research and will feature in future published reports.

The oldest passages in White Scar Cave are clearly the large fossilised phreatic tunnels, partially filled with clastic sediments and stalagmite. There are two independent series of these old phreatic tubes. Terminated at both ends by boulder chokes is the massive phreatic segment from Second Front, through the Battlefield and along the length of Western Front. This was probably originally formed by Chapel-le-Dale water looping in under the flank of Ingleborough, but the inlet and outlet to the present valley are both unknown. Northern Line appears to be a later inlet, largely phreatic but with some vadose features, and some of the high levels at the end of Moonmilk Inlet may be related to the blocked continuation of Second Front.

Independent of the Battlefield tunnels were the old phreatic tubes carrying water westward from Crina Bottom. The main route was along Sleepwalker; it originated either near Crina House or higher on Dowlass Moss and is now inaccessible upstream of Sump 2. From Aven 49 a tributary is now visible in the roof of Beat Street, but the main route continued along the short, mud choked passage to the west, and is now untraceable, but appeared to disintegrate before re-coalescing and forming the main line out of Whitehall Series. From there it is continuous, though heavily collapsed, through Crescent Hall, Hall of Justice and Carrot Hall to an impenetrable sediment fill just west of Far Streamway. A major branch originated in Great Rift and now lies in the roof of the streamway except where it locally disintegrates through the Roof Series and is filled with clay for the last few yards into the Hall of Justice. The upstream continuation beyond Great



*Stalagmites near the roof of Main Streamway.*

Rift, whether it is beneath the boulder floor or out of sight in the roof, remains to be found, and Great Rift Inlet was just a minor inlet. The tube of the Phreatic and Sump Series is still active and difficult to date. It could belong to a younger perched phreatic or could be an old tributary to the Great Rift tube. These upstream phreatic routes must have had their sources somewhere in the Greenwood Pot region of a proto-Crina Bottom.

The younger phase of development is represented by the long vadose canyons which form the present streamway. Downstream, the streamway probably had an early outlet through the bedding plane at the top of the Second Waterfall, but it then found a lower route, which was partially phreatic where ponded by a rise in the basement, out through the Show Cave Entrance. Even later it found the lowest route, now wholly vadose, out to the Water Exit. Upstream the canyon is cut in the floor of the older phreatic tunnels as far back as an active nick point at the cascade out of the Phreatic Series at the Great Rift junction. A similar canyon is incised in the floor of the Sleepwalker Series as far up as a nick point just beyond Aven 49. Little collapse has taken place in the main stream branch, but the larger tunnels, in the more heavily fractured rock, undercut by a less powerful stream, in the Sleepwalker Series have resulted in extensive collapse. The Big Bertha choke and the size of the Battlefield are both due to the floor of the chamber breaking down into the underlying streamway. Moonmilk Inlet is a tributary with significant vadose downcutting, but all the other inlets in the cave are remarkably immature except the avens at the end of Sleepwalker.

## Chronology

The two-phase, phreatic and subsequent vadose, development of White Scar Cave clearly relates to a massive regional rejuvenation associated with the cutting of Chapel-le-Dale, and it is almost inconceivable that this should not be a result of the climatic variations of the Pleistocene. A number of stalagmites from the cave have been analysed and dated on the basis of their uranium isotope contents. Most stalagmites, from both the Battlefield and the Main Streamway have yielded ages that are either post-glacial (i.e. less than 14,000 years) or are around 100,000 years, therefore placing their formation in the last Interglacial. Most significant however, is a single stalagmite from the roof of the Main Streamway which dates to 225,000 years ago. This can only indicate a “pre-glacial” origin for the old phreatic tubes, followed by rejuvenation probably by excavation of Chapel-le-Dale during the first subsequent glaciation, and then the development of the vadose canyons right through both subsequent interglacials (Hoxnian and Ipswichian) and into the post-glacial. Certainly the abundance of massive flowstone deposits in the roof of Far Streamway does suggest a considerable age for the vadose development, unlike many Yorkshire stream passages which may be entirely post-glacial.

Insofar as only one stalagmite has been proven to be so old, the above chronology must be regarded as a tentative suggestion. The analytical work has been done by R.S. Harmon of Michigan State University, and current and future work by Harmon and the writer is designed to either prove or modify this chronology.

## The Survey

The plan of the cave published with this paper is the result of a completely new survey carried out during late 1975 and 1976. For this the writer is forever indebted to the many cavers who acted as survey assistants and are listed below, and especially to some, notably the divers, who surveyed the extremities of the cave not visited by the writer.

Instruments used on the survey were Suunto compass and clinometer and fibron tape. The survey technique was what is almost the relatively rapid “Northern” method. Most of the passages were levelled with the clinometer, readings were to one degree and one foot, and stations were not marked. A grade 5 cannot therefore be claimed, though the survey is much better than grade 3, so it is best described as BCRA grade 4, though the grade falls off in the sumps and in the lesser inlets. A radio-location fix was taken from near the end of Sleepwalker up to Crina Bottom. The horizontal error was less than could be reliably measured off a 6 inches: 1 mile map and was not corrected – the survey of Crina Bottom is related to Sleepwalker as opposed to the Entrance. The vertical error was 28 feet, which was not unexpected in such a near-level cave, and was distributed. The survey was originally drawn at 50 feet to an inch, then photographically reduced in sections, fitted to a computer plot at 100 feet to an inch, and traced onto a master, which was further reduced in printing.



*Straw Chamber.*

## Acknowledgements

First and foremost, the writer is most grateful to Anthony Bagshaw, owner of White Scar Caves Limited, who not only permitted the current studies in the cave, but positively encouraged them, and through his generosity allowed many cavers to appreciate the splendours of White Scar as they assisted on the various work programmes.

The following are thanked for their patient work on the survey:- Alan Bailey, Julian Barker, Dave Brook, Mike Cowlshaw, Glyn Edwards, Jim Eyre, Dick Glover, Pat Halliwell, Ric Halliwell, Dave Hedley, Alison Hooper, Bob Hrijdij, Dave Irwin, Steve Jungnitz, Dave Kelsey, Alf Latham, Brian Matthews, John Middleton, Neil Montgomery, Jim Newton, Colin Ottway, Rob Palmer, Phil Pappard, Steve Pickersgill, Pete Seed, Pete Smart, Ray Smith, Phil Smyth, Oliver Statham, Steve Tarran, Chris Trevor, Vernon Unsworth, Dick Willis and Geoff Yeadon. The writer is also particularly grateful to Mike Cowlshaw who punched and computed the survey data, to Stephen Levy who plotted the survey on the Trent Polytechnic computer, to Russ Harmon who dated the stalagmites in his Michigan State University laboratory, to Ric Halliwell who provided some of the hydrological data, to Pete Smart who tested all the dye tracers, and to many others who took photographs, held maypoles, carried bottles, etc., etc.

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*The survey on the next page is a later version, available as a full-size file, White Scar Cave survey 1998, at [www.geophotos.co.uk/caves-and-karst/](http://www.geophotos.co.uk/caves-and-karst/)*



## Yorkshire

Ingleton

