SOME ASPECTS OF THE ORIGINS AND DEVELOPMENT OF THE GAPING GILL - INGLEBOROUGH CAVE SYSTEM

Part 2 The system

BRIEF HISTORY OF EXPLORATION

The first recorded mention of Gaping Gill occurs in John Huttons pioneering account of cave exploration, "Tour to the Caves in the Environs of Ingleborough" (Shaw, 1971), which first appeared in 1761. It in clear from Hutton's account that the connection between Gaping Gill and Clapham Beck Head was understood locally over two hundred years ago, but direct proof of the connection had to wait for a further one hundred and forty years. After Hutton, cave exploration In Britain was largely directed toward a the archeological excavation of cave deposits over the next few decades. The exploration, in their own right, of Ingleborough's caves and potholes was nevertheless growing, stimulated by successive editions of Hutton's "Tour to the Caves..." and by the growing appreciation or mountain scenery among educated tourists.

Exploration of the caves of the Gaping Gill area commenced in earnest in September 1837 with the landowner, James Farrer of Ingleborough Hall, who employed his estate workers to break down a series of stalagmite dams just inside the entrance of Ingleborough Cave, which was then known as Clapham Cave. This allowed a series of deep pools to drain which reached to within a few inches of the roof or the passages, and which hitherto had effectively prevented access to the extensive cave system beyond, (Farrer, 1849, Philips, 1853, Hill, 1913).

During the latter part or 1837 and the first half of 1838, Farrer's team discovered much of Ingleborough Cave as we know it today. In the course of a series of explorations of astonishing perseverance and extraordinary fortitude, considering the explorers' equipment, experience and the date, they reached Giants Hall and Lake Avernus (see Ingleborough Cave Plan by Philips. Fig. xx). James Farrer quickly turned the venture into a commercial proposition and Ingleborough Cave remains today one of the finest show caves in the country. A number or pioneer geologists, including Philips, Sedgwick, Marr and McKenny Hughes assisted with the exploration and survey. This resulted in special chapter by R.H. Tiddeman on the caves of Ingleborough, being included in the Survey Memoir of the Ingleborough area (ref. Dakyns et al, 1890). The officers of the Geological survey were so impressed with the clear way that the Ingleborough area demonstrated relation-ships between structure and scenery both above and below ground, that the Geological Museum Workshop was commissioned to prepare a special, geological relief model at Ingleborough. This model can still be seen in the Geological Museum, Exhibition Road, South Kensington, London. (Ref. Strahan, 1910)

One further result of the interest aroused among geologists by the exploration of Ingleborough Cave is that it was, and still is, the only cave in the country whose underground passages are shown in outline on the full range of the maps of the area, published by the Ordnance Survey. (See Sheet 98 “Wensleydale & Wharfedale” 1:50.000 First Series 1976. and "The Three Peaks" 1:25,000 Outdoor Leisure Map 1973.)

Also involved with early exploration of Ingleborough Cave were two local men, William Metcalfe of Weathercote House, Chapel-le-Dale and John Birkbeck of Anley House, Settle. Having thus acquired a taste for cave exploration with Farrer’s team, these two men made pioneer explorations of many of the open caves and potholes around Ingleborough during the following thirty-five years. Unfortunately, no first-known account exists today of their work, but it is believed that John Birkbeck attempted at least one, if not two descents of the Main shaft of Gaping Gill in 1842, by being lowered on the end of a rope. He reached a ledge 55m down (now named after him), and thus was the first man to look down into the vastness of the Main Chamber below. (Mitchell, 1949 and Lord & Mitchell. 1952.)

The exploration of Gaping Gill commenced in earnest on August 1, 1895 when Edouard Martel, the French pioneer of the science of speleology, in the course of a lightning tour of the caves of the British Isles, used rope ladders and a rope to descend the Main Shaft. After a descent lasting twenty-three minutes he spent an hour and a half exploring the Main Chamber, making measurements and sketches, which he later used to illustrate his account of the exploration (ref Martel, 1897 and Figs. xxx; copy of plates of Martel's book). Unknown to Martel, a group of Yorkshiremen under the leadership of Edward Calvert (and who were to become founder members of the Yorkshire Ramblers Club) had been planning to repeat Birkbeck’s descent since September 1894.

Despite having been forestalled by Martel, however, Calvert's group continue their plans and one month after Martel's visit two members reached Birkbeck's Ledge. On 9 May 1896, using a windlass and a system of pulleys, Calvert himself was lowered down the Lateral Shaft, which is parallel to the Main Shaft, and which bad been discovered some years earlier at the end of Jib Tunnel by McKenny Hughes. Calvert thus became the first Englishman to reach the floor of the Main chamber. (Calvert, 1899, 1900) Calvert's group returned to Gaping Gill many times in the next few years and in the course of these early visits they discovered those passages which led out of the Main chamber over the top of the East Slope. (Swindells 1970). In the many years which have succeeded these pioneer descents, many thousands of cavers have explored the system and from time to time major extensions have been discovered, both in Gaping Gill (including several alternative entrances), and in Ingleborough Cave. These discoveries are summarised in Table xx and Figs. xxx. Both cave systems have been surveyed several times to a reasonable degree or accuracy and according to the latest figures obtainable. Gaping Gill, including Car Pot, is over 11 kms in length and more than 150m deep. Ingleborough cave is over 3 kms in length and approaches to within 400m of Gaping Gill, but as yet no accessible connection other than hydrological has been discovered between the two systems.

Note: SInce Dick Glover wrote the above, a direct connection has been made between Gaping Gill and Ingleborough Cave by cave divers

SURVEYS OF THE GAPING GILL AND INGLEBOROUGH CAVE SYSTEMS

Any description of a system of caves should include plans, elevations and passage cross-sections, in order to demonstrate, in three dimensions, relationships between the various parts of the system and between the system itself and the surface topography. The techniques of cave survey (Ellis, 1976) are derived from those developed from surface use, but in most instances the nature of the underground environment precludes the use of even the simples surface levelling techniques and equipment. Instead, cave surveyors have evolved a compromise technique using magnetic compasses, clinometers and non-magnetic, flexible, measuring tapes. This equipment enables the main skeleton of a cave system to be measured along with details of passage width, height, cross-sectional form etc. These may be measured in, or estimated at significant locations, and appended to the skeleton plan and section when drawn up. The resulting accuracy of a survey can sometimes be assessed by the magnitude of misclosures of loops of circuits within the system, and/or by circuits which include surface traverses, if a system possessed more than one entrance. Recently, a new technique of magnetic induction survey has been proposed which enables the location of some or all underground survey stations to be referred to the surface both in plan, position and depth (see Chapter 9, by Glover, in Ellis 1976). Thus any number of loops can he closed via surface traverses, and hence gross or cumulative errors can be eliminated. These latter arise largely as a result of compass errors resulting from the presence of magnetic materials forming part of the cave surveyors equipment. In addition, problem may be encountered when reading the instruments in steeply inclined or very low muddy and/or wet sections of cave passage. Thus small, steeply inclined, meandering, active stream passages present the worst problems for the cave surveyor.

In the case of Gaping Gill, although the system possesses several separate entrances and therefore affords the opportunity for several underground circuits, and despite much of the system occurring at or around one stratigraphic horizon, it has proved very difficult, if not impossible, to estimate a degree of confidence which can be assigned to the location of any of its extremities, particularly those lying to the south-east. This uncertainty arises partly because much of the system in the vicinity of the Main Chamber was initially surveyed early this century, using techniques now known to be inaccurate, and the remainder of the system is so difficult of access, that most published surveys must be regarded with some degree of suspicion. In addition, all published

surveys are compilations, using the earliest as well as the latest data, and only having been adjusted where indicated by the presence of large closure errors. Thus comparison of the main published plans shows considerable differences in the direction and length of some of the passages. These differences are not necessarily based on the incorporation of more accurate survey information. Figure xx is based upon the first published survey made by the Yorkshire Ramblers club in 1896 and 1903; Figure xx is based upon the same club's final survey of 1927, reprinted for a British Association excursion; Figure xx is based upon a supposedly complete re-survey carried out by Simpson and Grainger, published in 1937. In 1952 Butcher and Gemmel published the "Key Plan to Gaping Gill", which shows an outline plan of the underground system in relation to a surface plane table survey of the various entrances and other surface details. (Fig. xx.) It differs in many respects from earlier versions, but as Butcher remarks: "with two dissimilar plans already available, the publication of a third... would have little value unless definite evidence on which to assess its accuracy was forthcoming. Fortunately, the recent discovery of further entrances in addition to the two known for many years, have made a number of closed traverses possible with a consequent exact assessment of the closing error and a great improvement in accuracy by consequent adjustments". (Butcher, 1952.)

On this basis, and because Butcher provides numerical values for closure errors, observed by comparing underground with surface loops between entrances, Butcher's Key Plan may be regarded with a great deal more confidence than earlier versions. Figs. xx and xx are based upon two versions of yet another complete re-survey undertaken by the Peveril Underground Survey Association, under the supervision of Grainger and are dated 1962 and 1968 respectively. Whilst the earlier version differs only in minor aspects from Butcher's Key Plan, the 1968 version contains a great deal more information, including the latest discoveries of the Whitsun Series and the Far Country. However, on the basis of a supposedly accurate underground closed traverse from the Main Chamber, via Mud Hall, Hensler's Stream Passage, Southeast Passage, back to Main Chamber, Grainger swung the whole of East Passage some 100 further south. (This alteration is now known to be totally erroneous.) The 1968 Grainger version was also notable in that it included a projected east/west elevation, this being the first published section of the system since 1896.

Since the new position of the East Passage was in patent contradiction to all previous published information it was re-surveyed in 1968/69 by cavers from Leeds University. They showed that a cumulative error had been incurred by Grainger's team in the crawls linking Hensler's Stream Passage with Mud Hall and with Southeast Passage.

In 1969/70 Yeadon, assisted by members of the Kendal Caving Club, produced another compilation based on survey information from Butcher, Grainger and the Leeds team, and incorporating the latest discoveries of the Far Waters, beyond Far Country, and the results of dives carried out in Terminal Lake in Ingleborough Cave. He also incorporated this relatively reliable Gaping Gill Survey with the Bradford Pothole club (Noland 19xx) survey of Ingleborough Cave, together with scaled-up surface topographical information based on the 6 inch to 1 mile Ordnance Survey Map (Fig. xx).

In 1975 Meredith published yet another compilation based largely on Yeadon's previous work, but incorporating modifications based partly on his own re-surveys of those parts he knew personally to have previously been shown in error, and partly on personal information provided by Yeadon, Glover and cavers from Leeds University. Immediately prior to publication, Meredith's new outline plan was checked against a computer line plot, based upon completely new survey data provided by Yeadon and his Kendal Caving Club team. The computer programme, print out and outline plot were provided by Gardner of Lancaster University. Correlation between the Meredith plan and the computer outline plot (as far as it went) was very good. It may be assumed therefore that the Meredith version is the most accurate survey of the Gaping Gill and Ingleborough Cave systems presently available. For the purpose of this publication the Meredith survey has been re-drawn, incorporating minor details from earlier versions, together with a variety of additional information obtained personally by the author in the course of morphological mapping. To ease the problems of locating sections of passage referred to in the text on

the plan, a grid system has been superimposed. This is based upon a subdivision of the National Grid system for the area. Thus for the purposes of this publication, Fig. xx represents the definitive area map showing surface detail superimposed on cave outline, whilst Figs. xx and xx are the definitive plans of Gaping Gill and Ingleborough Cave respectively. Reductions in scale imposed by space limitations have necessarily resulted in the loss of an appreciable amount of important detail (see Figs. xx and xx) and therefore the description of each part of the system in the next section is accompanied by an appropriate enlarged scale plan and/or elevation, with cross sections, as appropriate.

A DESCRIPTION OF THE GAPING GILL SYSTEM

At the blind southern end of the valley of Fell Beck where the stream has cut through the fluvio-glacial deposits and commences to flow over the upper beds of the D1 limestones, the valley widens and low grassy terraces of peat covered glacial deposits occur on either bank rising one to two metres above the boulder-strewn stream bed. Solid rock is visible in the stream bed in places and can be seen to be thinly bedded and well jointed. The stream drops over a series of small steps from bed to bed, but in low flow conditions many of the joints take most of the flow, some of which reappear at the base of the next lower bed. Downstream of the point of entry of Thack Pot Sike, which is the lowest tributary to Fell Beck draining the east flank of Little Ingleborough, Fell Beck executes a series of at large meanders swinging south east, then south-west, then south east again. Solid thinly bedded limestone outcrops on the outside of each bend, and it can be seen that these contain nodular concretions around shell fragments etc. It may therefore be assumed that these limestones comprise the Girvanella Band, referred to earlier, and that they can mark the boundary between the D2 fossil zone, comprising the Yoredale Series, and the D1 zone, the upper unit of the Great Scar Limestone.

Rat Hole

A series of small fissures and low cave passages occur in the west bank on the outside of the last bend of Fell Beck before the Main Shaft. These were first exposed in 1909 after a very heavy flood (Rule 1910) and are known as the Rat Holes. During the bi-annual winch meetings a dam is constructed immediately downstream of the Rat Holes and as much water as possible is diverted into them. This allows winch descents of the Main Shaft to be made under relatively dry conditions. The Rat Hole sinks lead to a series of small tight tubes running under the west bank at the depth of 1 - 5m. Several branches combine to form a small vadose trench passage as it approaches the Main Shaft (Broderick 1912) The combined flow from the Rat Hole passage drops over a 5m waterfall into a narrow rift chamber known as Fissure Chamber. Here the original explorers reported an apparent dip of the limestone bedding of 480 to the south, although it is now believed that this is more likely to result from oblique faulting associated with the Main Chamber Fault. It has not proved possible in recent years to re-enter the Rat Hole stream-way in order to verify this surmise, since all the tributary tubes now contain solid, partial, chokes of gravel an turf, washed in as a result of damming operations. Fissure Chamber is aligned north-west and southeast and at both end holes in the floor lead down to the top of a 10m diameter shaft with magnificently fluted walls and which is at least 70m deep. It must in fact continue beyond this point, straight down into the Main Chamber.

(Rat Hole was cleared out by D C Mellor et al over a number of years and in 1984 re-opened for the first descent since 1935).

Jib Tunnel

Downstream from the Rat Holes, Fell Beck swings south again, running over wide, flat-bedded limestone slabs, before beginning to drop over a series of small waterfalls. Several calcite veins of up to 1cm thick can be seen in section in the stream bed and are an indication of the proximity of the Main Chamber Fault zone. Low cliffs of solid rock appear in both banks, with those on the east bank being surmounted by a wide platform on which the winch is usually erected. On the last ledge which forms the lip of the Main

Shaft, a large block of limestone some 2m3 has become detached from the west bank. Behind this block an initially low narrow vadose trench, known as the Jib Tunnel runs south-west for some 6m before ending abruptly at the head of a large open shaft. This is known as the Lateral Shaft, and drops clear to the floor of the Main Chamber, 110m below. Jib Tunnel and the Lateral Shaft were first described by McKenny Hughes, who noticed the passages behind the detached block in 1872 after an exceptionally heavy storm (McKenny Hughes 1887). Jib Tunnel owes its name to the jib, or gantry, constructed by the Yorkshire Ramblers Club in I906, and which enabled them to utilise a hand-operated winch system for descents of the Lateral Shaft. This had the advantage of providing a straight drop into the Main Chamber, thus avoiding Birkbeck's Ledge halfway down the Main Shaft and which, caused problems with rope abrasion. The main disadvantage of this method of descent however, was the fact that it was not possible to avoid passing through the waterfall issuing from Spout Tunnel some 10m below. A large beam of wood was still wedged firmly in place at the end of Jib Tunnel until recently, projecting out over the head of the Lateral Shaft for 1m. This was the last remaining portion of the original wooden gantry and was in a remarkably fine state of preservation, despite some seventy years of intermittent soaking in the waters of Fell Beck whenever a flood occurred.

Spout Tunnel

10m below the lip of Jib Tunnel a waterfall enters the Lateral Shaft from the North Wall. Known as Spout Tunnel it was first explored by members of the Yorkshire Ramblers Club (ref. Rule 1909}. It was surveyed by the same Club the following year and they showed that much of the water entering Lateral Shaft from Spout Tunnel originates from a number of sinks in the bed of Fell Beck upstream of the Rat Holes (ref Broderick 1912) . Spout Tunnel is entered by a pendulum move made on the end of a 10m ladder hung from the South Wall at the end of Jib Tunnel. The passage runs north for a short distance, rising 3m, and then after passing a large boulder-choked inlet on the left. It then turns and runs under the winch platform for a distance of 75m. The first 50m of this passage averages 1m wide, is almost level and takes the form of a small vadose passage. Its height varies between 1m and 3m, but at one point it rises to a narrow fissure nearly 10m high, but too narrow to enter.: At this point, according to Broderick's 1912 survey, the beds to the north of the passage appear to "dip south at an angle of 480. This feature was also noticed in the fissure chamber at Rat Hole. The text accompanying Broderick's survey however makes it quite clear that this anomalous dip feature is visible in the passage beyond Junction Chamber, mentioned below. This fact is confirmed by the survey accompanying a description of the recent visit to the Spout Tunnel system made by members of the Craven Pot Hole Club. (ref. Beck 1976.)

At approximately 50m from the entrance to Spout Tunnel, the triangular-shaped Junction Chamber is reached where the bulk of the water enters via a 10m high waterfall down the North Wall. Beyond Junction Chamber the passage swings south-east for a further 25m diminishing in height to under 1m. A high narrow fissure heading south at 480 is visible in the roof of part of this section. At the end of the passage the roof rises to over 7m and two small inlets enter from a point 4m up from the North Wall. Both inlets are fed by small trickle issuing from a tight fissure some 7m higher still. The top of the first climb, a small tight passage, leads north-west for a short distance before dropping down from part of the slot in the roof of the preceding portion of the passage. Members of the Craven Pothole Club found all inlets too tight to enter, although they suggest that it might be possible to extend the passage of floor level by digging. The main inlet waterfall at the Junction Chamber is approximately 50m high with a big pool filled ledge at 10m. The passage above runs east then swings sharply northwest for some 50m before becoming too small to follow. At this point the waterfall can be scaled and the passage could probably be enlarged by excavation. However, the survey shows this point lies only a few metres below and to the south-east of the bed of Fell Beck in the vicinity of the P1 and P4 sinks, as designated by Broderick, 1912.

Broderick expressed his opinion that both the Rat Holes and Spout Tunnel sinks and their associated feeder streams in the bed of Fell Beck itself are undergoing rapid enlargements or re-invasion as much of the debris choking their upper ends is washed out. He predicted that both streams would soon be sufficiently enlarged or re-

excavated to take all the low water flow of Fell Beck, a process which would facilitate descents of the Main Shaft. Today some sixty years later this is the case. Under normal low flow conditions, very little water falls over the lip of the Main Shaft. Only in very heavy flood, when both the Spout Tunnel sinks and the Rat Hole prove incapable of taking the full flow, does water cascade down the rock steps below the Rat Hole and over the lip of the Main Shaft.

Main Shaft

As mentioned above, downstream of the Rat Holes, Fell Beck flows over a series of wide, flat limestone slabs which are well jointed and which are separated by small steps of 0.5 to 1.5m. Each step represents one bed of rock with thick shale bands between. The edge of each step runs northwest/ south-east (1420 true) this being the dominant joint direction in this vicinity. After two final steps of approximately 2m each, the stream flows over a flat platform measuring some 2m by 4m, the edge of which forming the lip of the pointed oval aperture of the Main Shaft. This hole is 10m wide by 5m across, with the major axis aligned also on 1400 true. The back (southern) wall of the shaft, above the final platform, forms a steep grassy, semi-circular, blind end to the valley of Fell Beck, rising some 15m to moor level. The first 2m of this slope appear to be developed in solid rock, but the remainder of the upper portion is composed of soft clastic materials, comprised largely of rounded gritstone pebbles in a sand and clay matrix, presumably of fluvio-glacial origin.

The Main Shaft drops almost vertically from its lip for about 60 m to Birkbeck's Ledge. A one metre thick band of breccia is visible in the south-east corner for most of this distance, although vertical displacement of beds across the long axis of the shaft is less than 50cm at the top. Approximately 20m down, the north-west corner of the Main Shaft opens into the much larger Lateral Shaft containing the Jib Tunnel and Spout Tunnel waterfalls, falling freely 110m to the floor of the Main Chamber below, and thus constituting the highest free falling waterfall in Britain. Birkbeck's ledge is a sloping shallow scooped platform some 2m wide by 7m long, highly polished, with many small fractures etched into its surface upon which lie assorted pebbles and boulders washed or thrown down from the surface. Some 5m below the lip of Birkbeck's Ledge, the south wall of the Lateral Shaft abruptly disappears as it drops through the roof of the Main Chamber. The north wall, however, continues vertically downwards for a further 35m and forms part of the north wall of the Main Chamber.

Main Chamber

The Main Chamber of Gaping Gill is much the most impressive feature of the whole system and deservedly famous. It takes the form of a huge clean-washed cavity whose roof is totally unsupported. It is over 145m long, along an axis running 1020-2820. The Chamber is widest near the middle where it reaches 25m across and it tapers towards each end. The chamber reaches a maximum height of 35m close to the long, vertical North Wall, where the Main Shaft enters approximately mid-way between the two extremities. Under normal weather conditions, i.e. low flow and absence of clouds or hill fog on the surface, enough daylight enters the Chamber via the Main Shaft to enable the shape and size of the Chamber to be appreciated without the aid of lights, once one's eyes have become accustomed to the low level of illumination. The South Wall of the Main Chamber rises vertically from the floor some 8m before sloping out at an angle of 550 to the horizontal. The change of angle occurs abruptly immediately above the 50cm thick bed of limestone clearly visible in section along the whole of the South Wall. This is the Upper Porcellanous Band. The overhanging roof above the Porcellanous Band rises uniformly until it meets the North Wall at a height of approximately 35-40m above floor level.

Over much of the length of the Chamber a narrow fissure is apparent where the two walls meet. This fissure is also parallel to the long axis of the Main Chamber. The fissure widens at the point of entry of the Main and Lateral shaft. The Rat Hole waterfall enters the Chamber via this fissure approximately halfway between the Main Shaft and the west end of the Chamber. At each end of the Chamber the fissure closes, the roof becomes arched, then flat above eastern and western extremities.

The floor of the Main Chamber consists of a gently undulating layer of black, water-worn sandstone boulders and pebbles rising to its highest point close to the plunge pools of the Lateral Shaft and the Main Shaft

waterfalls. This boulder floor slopes gently away from the highest point towards both walls. 20m to the west of the highest point an extensive flat-topped bank of sand, capped by a thin layer of sticky mud mixed with peat debris, occupies much of the western end of the Chamber floor. Prior to a series of severe floods in 1906, this sandbank apparently occupied nearly all the floor (ref. Horn, 1906, page 206, and Ref. xxx The nature and distribution of floor sediments in the Main Chamber is shown in Fig. xxx.

Under normal weather conditions, and in the absence of any surface diversion dam, most of the water from Fell Beck enters the Main Chamber as three main waterfalls: from the Main Shaft, from Jib Tunnel and from Spout Tunnel down the Lateral Shaft; and the Rat Hole Waterfall, respectively, running from east to west. At the base of each waterfall a shallow pool has developed in the boulders. The water from the Main Shaft and Lateral Shaft waterfalls normally flows east, along the base of the North wall in a shallow channel and sinks between the boulders as it approaches the base of East Slope. Some of the Lateral Shaft water, however, flows west, close to the North wall, into the Rat Hole plunge pool. The outflow from this continues to flow in a westerly direction close to the North wall in a trench excavated around the edge of the sandbank which occupies the west end of the Chamber. This stream sinks at various points depending upon the quantity of water. Under flood conditions as many as eight separate inlet waterfalls have been reported. In addition a major flood inlet has been seen to enter the Main Shaft in the middle of its south side some distance above Birkbeck Ledge.

It is clear that the points where the water sinks under normal flow conditions are not capable of absorbing the full volume of water entering the Chamber during peak floods. Debris in the form of wooden planks, grass, animal bones (usually sheep), bottles and beer cans have been found washed into crevices amongst the boulders in places as high as 15m above Main Chamber floor level. At the peak of floods of this magnitude the whole of the Main Chamber must undergo both solutional and mechanical attack by high pressure jets and spray of aggressive water driven by the gale force winds which roar around the Chamber and which are generated by the force of the inlet waterfalls. It has been reported that under these conditions the whole Chamber resonates or pulses like an organ pipe of enormous dimensions with a fundamental frequency of about 1 cycle per second.

Under normal weather conditions, however, all the water entering the Chamber sinks through the floor or at the base of the North wall and (with only two possible exceptions) is not encountered anywhere in the 11km of cave passage which connect with the Main Chamber. The two exceptions are: a) The stream entering and immediately sumping at the bottom of West Pot, and b) the normally static pool of water occupying the bottom of South East Pot. Both these localities are described later, as also are the implications of the apparent absence of any accessible main stream route, so far discovered between the Main Chamber and Terminal Lake in Ingleborough cave.

The East & West Boulder Slopes

The North and South Walls of the Main Chamber meet the floor at right angles around most of the perimeter of the Main Chamber and at both east and west ends the walls converge until they axe some 10m apart. The ends of the chamber from these points onward are occupied by steep mud-covered slopes of rough, shattered blocks of limestone. These boulder slopes are the only significant accumulations of limestone boulders encountered in the whole of the Main Chamber and appear to have formed as a result of collapse of walls and roof of the Main Chamber extremities, i.e. they originated in situ, and show no sign of water polishing or rounding which would have occurred if they had entered the Chamber from the surface via one of the waterfalls.

The West Slope rises 15m at an angle of 500 (?), the last 3m of this takes the form of a rock step. Here the walls have converged to within 3m of each other. Above the rock step a flat-roofed bedding plane passage 1m high and floored with sandstone pebbles cemented together with stalagmite runs south towards West Chamber.

At the eastern end of the Main Chamber the East Slope rises 22m at an angle of 450 (?) and ends in a 2m high rock step where the north and south walls of the chamber meet. Above the rock step a bedding plane aperture, 1m high by 2m wide leads over a bank of stalagmite into Old East Passage. Along the full length of that part of the south wall of the Main Chamber in contact with East Slope, large slabs and spikes of limestone can be seen peeling

away from the hanging roof. In several places along this section this has resulted in the formation of low steeply dipping, mud and boulder choked passages between the hanging roof and the main boulder pile. From evidence of flood debris jammed into these passages they allow water to escape from the Main Chamber whenever flood occur of sufficient magnitude to raise the water level in the Main Chamber by 10-20m above floor level.

At several places on the North Walt of the Main Chamber where it meets the East Slope, the North Wall show evidence of faulting in the form of slickensides, but it is not possible to determine the direction of throw since the rock surfaces concerned are irregular, shattered and mud coated. A number of avens enter the arched roof at the Main Chamber over the East slope, but these appear to be small phreatic features now largely choked with stalagmite. Near the top of the slope, the shape of the walls and roof suggest that this end of the Main Chamber developed originally as a series of fault controlled phreatic chambers approximately 10m in diameter whose floors and walls collapsed into the Main Chamber, as the latter extended eastward, undermining the chambers, at some early stage in the development of the Main Chamber itself.

The Porcellanous Bands

Two conspicuous white bands of rock can be seen, in section, in North and South walls of the Main Chamber over most of their length. The Upper Porcellanous Band averages 50cm in thickness and occurs approximately 8m above the floor of the Main Chamber. It consists of a dense blue-white micritic limestone or calcite mudstone, almost completely non-fossiliferous and exhibiting a conchoidal fracture. A lower band also exhibits a similar white weathered surface outcrop, 3m below the Upper Porcellanous Band. However, close examination of this bed, which averages no more than 20cm in thickness, reveals that it consists largely of a coarsely crystalline limestone. However, a true porcellanite is developed in places on its lower surface but never reaches a thickness greater than 50cm and over much of the perimeter of the Main Chamber it is completely missing. The 3m thick bed of limestone lying between these two horizons exhibits marked current bedding and contains thick accumulations of brachiopods, the vast majority of which were deposited convex surface up. This bed is coarsely crystalline and in addition to the high density of complete shell fossil referred to above, it contains a high proportion of shell fragments and crinoid ossicles. The bottom 30cm of this bed contains a high percentage of calcite mudstone matrix and in consequence has acquired a very white weathered patina.

As mentioned earlier, these two horizons can with confidence be identified as the twin Porcellanous Bands commonly used to denote the boundary between the S2 and overlying D1 fossil zones of the Great Scar Limestone. Along much of the south wall of the Main Chamber small scale phreatic solution appears to have taken place both immediately above and below the Upper Porcellanous Band. In addition the hanging roof of the Main Chamber commences at this horizon above the south wall. At both ends of the Main Chamber the upper Porcellanous Band can be traced into the boulder slopes. At the West Slope, however, it can be clearly seen in section across the face of the slope and here it outcrops at the same level in both north and south walls. By contrast, the upper Porcellanous Band in both walls disappears beneath the pile of boulders forming the East Slope.

At this end of the chamber the outcrops of this bed in North and South walls can be seen to lie at different levels. Levelling across the chamber at this end and along the line of the outcrop of Upper Porcellanous Band in both walls of the Main Chamber has established the following features: in the north wall the upper Porcellanous Band shows an apparent dip to the west of between 10 and 1.50, but along the line of the South Wall it exhibits an apparent dip to the east at the same angle. This difference in apparent dip is sufficient, over the length of the Main Chamber, to cause the two outcrops to differ in level by over 4m at the east end of the Chamber. In addition, in the middle of, and close to, the South Wall, a clean-washed, isolated buttress of rock, surmounted by a pinnacle, rises from floor level to a height of nearly 10m. The outer face of this buttress is in part composed of calcite vein infill. The Lower Porcellanous Band horizon can be seen to step up some 30-40 cm from south to north, through the thickness of the buttress. It would appear that this isolated buttress is the last remaining fragment of the veined, shattered, mass of rock which formerly occupied the space now occupied by the Main Chamber

itself.

Along the length of both North and South walls of the Main Chamber sets of joints can be seen which intersect the Chamber axis obliquely. The joints have suffered preferential erosion and in places penetrate the chamber walls for several metres. They are for the most part vertical, ranging from 5-40m high and are orientated 1420/3220. The joint spacing varies, from place to place, between 0.55m and 2m with the closest joints occurring at the west end of the Chamber. A number of these joints in both walls of the Main Chamber show evidence of solutional widening under phreatic conditions and give rise to alcoves or narrow rift passage, extensions to the Main Chamber. In the North Wall of the Main Chamber to the west of the point of entry of Rat Hole water, just one such widened fissure opens in the North Wall of the Main chamber. This is the West Pot sink (Figure xx). Under normal flow conditions most of the water entering via the Lateral and Rat Hole Waterfalls sinks at this point. If enough water is entering the Main Chamber the noise of a waterfall can be heard issuing from the fissure, but it becomes too narrow to allow entry after 1-2m.

West Fissure and West Pot

Halfway up the west slope of the Main Chamber, a low arch opens in the North Wall, leading to the West Fissure. This commences with a 3m drop over boulders jammed across the 1m wide passage. A floor of jammed boulders runs a further 7m in a north-westerly direction. At this point a 10m deep narrow slot in the floor emits a strong draught and the roar of falling water. Beyond this point a 2m climb over shattered flakes leads to a 2m drop onto another false floor. Ahead, the fissure tapers to a blind end with a further 10m deep narrow slot in the floor. Here the waterfall can also be heard, but much less clearer than in the previous floor slot.

Halfway up the west slope of the Main chamber, directly above the Upper Porcellanous Band, a low bedding plane squeeze, The Letterbox, leads for 2m to a 2m drop into another solution widened joint passage. This runs for a distance of 20m parallel to West Fissure, dropping 5m over jammed boulders before ending on the lip of a deep shaft developed along the same line. The roof at this point cannot be seen and lies at least 50m above. The shaft, known as West Pot, drops vertically for 30m. At the foot of the shaft, a boulder slope leads downwards, still in a north-westerly direction, until it enters a narrow passage, 20m long, 1m wide, varying in height between 1m and 7m. A stream enters the passage from a horizontal bedding crack on the right, part-way down the boulder slope, and flows down the remainder of the passage to end in a siphon pool, 40m below Main Chamber floor level. Dye testing with fluorescein has proved that this stream originates at West Pot sink. The flow-through time was only five minutes, indicating open, vadose, passage between the two points.

North Passage and North Passage Tube

The Main Chamber is at its widest directly below the point of entry of the Main Shaft. East of this point the North wall curves gently to the south, ending at a prominent buttress where the Upper Porcellanous Band is clearly visible. Beyond the buttress a 10m wide, 20m high, passage enters the Main Chamber from the north: this is North Passage. It runs back along the major joint direction, 1420/3220 for some 120m. The passage floor rises steeply for 10m at an angle of 450 over a slope of large limestone boulders thickly coated with mud and clay. Above the boulder slope the passage levels out with a floor of hard, dry mud. In the roof, phreatic solution pockets run along the joint line. Block collapse of both walls has resulted in the upper portion of the passage having a 10m by 10m square cross-section at its outer end. Below this part two successive vadose canyon give sections can be seen incised in the walls. The lower ogive is cut in the Upper Porcellanous Band and walls exhibit large, shallow, flow-marks (10-20cm in diameter) indicating a former long period of slow flow a north-westerly direction.

At the inner northern end of North Passage, the dry mud floor rises to meet the roof. Beyond this point, excavation undertaken over many years has revealed a low tunnel with a dry, loose, sand floor and solid rock roof, with phreatic solution pockets along the joints. This has never been surveyed but it is estimated that it continues for a further 100-150m in a north-westerly direction, ending 100m below the west bank of Fell Beck, in the vicinity of the Rat Hole sinks. Beyond the furthest point reached by excavation, the passage can be seen to continue, but is only a few cm high. A gentle

air current usually flows out towards the Main Chamber from this point.

(See survey North Passage by SEW and an North Passage Extension by P B Warren Ref. CPC Records 20 Oct 1990 and 24 Nov 1991)

Five metres to the east of North Passage, a 1m diameter phreatic tube of almost circular cross-section sits directly on the Upper Porcellanous Band. It was originally completely choked but has been excavated for 3-4m in a north-westerly direction. The fill consists of an upper portion, 10cm thick, in contact with the roof of plastic brown clay. The remainder of the fill consists of water-worn sandstone pebbles in a sandy matrix. No scallops or flow marks are discernible on the walls or roofs of the excavated portion and it is therefore not possible to determine the direction of the flow of water which formed the passage.

East Pot

At the base of the East Slope, directly in line with the entrance of North Passage, a small hole between large jammed limestone boulders descends vertically for 2m into a small chamber formed between more jammed boulders. A small hole at the south-eastern corner of this chamber drops 10m into a large elongated chamber which runs south-east for 15m under East Slope. Both roof and floor of this chamber, known as East Pot, consist of large jammed boulders. The north wall, directly below the point of entry, is almost vertical, but the south wall slopes steeply in a southerly direction at an angle of 550 to the horizontal. Both walls of the chamber consist of completely shattered rock.

At the south-eastern end of the chamber, a shallow hole in the floor is usually choked with flood debris. Above, a 7m climb leads to solution widened joint tubes bearing 1420, but which are too narrow to enter. A small stream enters the chamber issuing from the boulders at the top of the 10m pitch. It appears to be the same water that sinks at the foot of East Slope and which originates as an easterly outflow from the main splash pool directly below the Main Shaft. There is clear evidence on the walls, floor and roof of East Pot that it fills completely with water in times of flood.
(see East Pot survey by SEW 1986 Ref. CPC Record 4 Oct 1986)

South Fissure

Under flood conditions not all the water entering the Main Chamber via the Lateral Shaft and Rat Hole Waterfall can be accommodated by the West Pot sink. The remainder continues to flow west against the North wall in a deepening trench cut in the sandy deposits which floor this end of the Main Chamber. Some water sinks at the foot of West Slope, but the remainder continues past the foot of the slope until finally sinking in several joint fissures which run south-west on 3270 at the foot of the South Wall. As mentioned earlier, in recent years, possibly due to the relatively recent reactivation of the Rat Hole sinks, a considerable quantity of sand has been removed from the hitherto flat floor of the Main Chamber in this area, and it appears that these fissure sinks in the South Wall are still opening out. The best developed sink, known as South Fissure, runs south-east, into the South Wall of the Main Chamber, at the end of the flood water trench, at a distance of 35m from the foot of West Slope.

The South Wall of the Main Chamber is here recessed to form a tapered alcove, 10m high, and over 2m wide at the entrance. The floor of South Fissure consists of in-washed sand, pitted by several conical sink hollows, which often contain quantities of flood debris. At the end of south Fissure the Upper Porcellanous Band forms a complete bridging slab. Above it, a low mud-choked triangular passage extends a further 1-2m. Flood water also appears to sink at several other points between South Fissure and West Slope, depending upon the size of the flow. Here, where the overhanging South Wall meets the sandy floor of the floodwater channel, the solid rock roof exhibits a high joint density, and a considerable quantity of rock, in the shape of large slabs, 1-5cm thick, is in the process of collapsing as a result of being undercut by floodwater.

South Passage Boulder

60m to the east of South Fissure, a large block of limestone, South Passage Boulder, approximately 10m by 10m and 6m high, rests on the Main Chamber floor close to the South Wall adjacent to the foot of the East Slope. Above and behind the boulder a low oval cave entrance leads to South Passage. Prior to heavy floods in 1950 this block of limestone formed a projecting buttress directly attached to the South Wall at this

point. Floor subsidence caused by the flood appears to have resulted in the block becoming detached from the South Wall, It has dropped 1.5 - 2m and moved east approximately 5m. The top of South Passage Boulder is flat and consists of a 2m x 2m slab of the Upper Porcellanous Band still in situ. The upper surface of this capping of calcite mudstone shows signs of recent solution, presumably as a result of occasional submergence in aggressive flood water. In consequence the slab exhibits a clean, polished surface. The same process has also resulted in solution of the more coarsely crystalline limestone underlying the capping of mudstone. However, the two types of rock appear to have reacted to this type of solution in completely different ways. The upper surface of the bed underlying the slab of Porcellanous Band contains several joints which have been the site of preferential solution, with the result that it now possesses a number of grooves, each 1-2cm wide and 10-20cm apart. The alignment of these corresponds with the predominant joint direction visible in the walls of the Main Chamber. In complete contrast, the slab of Upper Porcellanous Band does not appear to contain joints of this nature or direction. Instead it appears to contain a very large number of tiny gash fissures which run across and through it in 'en echelon' for distances of only 1-2cm. The spacing between these 'micro joints' is of the same order of magnitude, i.e. 1-2cm, and they appear to dip into the slab at all angles. In addition, instead of having been etched out by solution as in the body of the boulder below, they appear to be full of re-crystallised calcite which appears to be less soluble than the mudstone matrix since they now stand proud of the surface of the mudstone slab by as much as 1mm.

Elsewhere in the Main Chamber wherever this main Upper Porcellanous Band is exposed in section in the walls, it can be seen that very few if any of the major joints visible in the D1 limestones above or the limestones below pass through the Porcellanous Band itself. Thus the impression obtained from observations of the upper Porcellanous Band in section in the Main Chamber and its relationship to the joint patterns both above and below it, is that most joints stop at this horizon. In consequence, the PB might be expected to act very much like a thick shale bed in not allowing down-joint percolation of water to pass through it.
This is a feature of some importance in understanding the origins and subsequent development of the network of passages found elsewhere in the Gaping Gill system.

Old East Passage, Mud Hall, Far East Passage

Three passages have so been discovered leaving the Main Chamber and giving access to the 11kms of cave system lying to the east, southeast and south of the Main Chamber itself. These three routes are:

(1) from the top of East slope a small window leads into Old East Passage, much of which is morphologically related, in origin, to the Main Chamber

(2) from the top of the West Slope an initial low passage leads into West Chamber

3) the low cave passage opening behind and above South Passage Boulder, is the start of South Passage. These latter two routes soon converge, and appear to act as overflow exit routes water leaving the Main Chamber under very heavy flood conditions.

Old East Passage

The name Old East Passage refers to the first section of the series of passages leading in an easterly direction from the top of East Slope and which connects the Main Chamber with Mud Hall. Entry to Old East Passage is gained by climbing a short fixed iron ladder up a 2m rock step at the highest point of East Slope, and crawling through a 1 x 2m natural aperture over a bank of flow-stone. This opening is not man-made as it was found to be open by the original Yorkshire Ramblers Club exploration team, on their first descent into the Main Chamber (Calvert 1899). A short scramble over the bank of flowstone, which slopes down from the left, leads directly into a broad low mud-floored bedding chamber, extending 20m in an easterly direction. The north wall of this chamber is vertical, rising 1 - 2m to an approximately flat roof. The chamber roof is crossed obliquely by two joints trending north-west/south-east. Along both joints, solutional widening has resulted in the formation of small (2-3m high) 'gothic' arch roof alcoves.

Along the southern side of the chamber the roof curves down and meets the

mud floor at approximately the same angle (550 to the horizontal), as the overhanging, southern wall of the Main Chamber. The first of these two joint alcoves in the roof is aligned 1420/3220 At its north-west corner it is choked with a bank of stalagmite deposited by water entering down the joint. At its south-eastern end the mud floor of the chamber slopes away along the line of the joint, leading to a series of small cavities, one above another, and which consist of spaces between large collapsed blocks of limestone. These lie jammed between the southerly dipping roof and the mud floor. This is the start of the Booth-Parsons Crawl, and. will be described in a later section.

The second major joint crossing the roof of this first chamber lies 7m beyond the first, and is aligned 1200-1300, but the roof alcove is much less well developed and there does not appear to be any lateral or vertical extensions, either to the north-west or south-east. The walls of the chamber converge a few m beyond this second cross joint and the roof drops to meet the floor. At this point the mud floor is covered by a 10-15cm thick layer of stalagmite. Old East Passage continues as a small hole dropping through this stalagmite crust. It runs for a further 2m as a small irregular tube running between boulders buried in the mud before rising steeply 1.5m, and emerging into the next chamber through a hole which breaks through another thick stalagmite crust. This layer of flowstone appears to have been deposited by water flowing down a joint fissure in the northern corner of this next chamber.

This second chamber resembles the first but on larger scale. Its north wall rises vertically for some 2-3m and runs parallel to the long axis of the Main Chamber (1020/820) The roof dips south at the same angle as the Main Chamber roof, and eventually meets the floor of mud, boulders and calcite deposits. This results in a 20-30m wide chamber whose cross-section resembles a right-angled triangle. It extends back beyond the point of entry, in a north-westerly direction, for some 20m as a tapering alcove filled with a mound of mud, sand gravel and boulders, which eventually seal it off. Slickensides can be found on the south wall of the alcove, indicating horizontal movement in a sinistral direction.

To the east, the chamber gradually narrows, and the roof lowers, except close to the north wall, which continues to run parallel to the Main Chamber's long axis for a further 60m. Cross joints aligned 1220/3020 cut diagonally across the low hading roof and result in solutional arches which disappear southwards below the fill. These appear to have acted as outflow channels at some former time, since under each, shallow floor gullies slope down in a southerly direction, ending in small choked tubes after 1-2m. After 60m the roof adjacent to the north wall rises abruptly forming an inlet aven some 10m high, down which a considerable quantity of saturated water once entered, leaving a large bank of flowstone on the north wall. The passage continues as a 1m wide fissure turning slightly to bear 1120 then 1170 and back to a 1120 as it approaches Mud Hall. The south wall of this fissure shows traces of slickensides near its beginning. Due to a partial coating of calcite, it is difficult to determine the direction of movement. There would appear to be indications of horizontal movement in both directions, but in the main, the movement appears to have been sinistral. The north wall and floor of the last section of this fissure passage are well decorated with flowstone in the form of curtains, floor columns and massive wall formations. Two banks of flowstone attached to the north wall in this section of the passage provide evidence of a long-lasting and complex series of stages of development for this portion of Old East Passage. The first of these formations is known as the Canopy and consists of a semi-circular plate of flowstone, projecting out from the north wall for a distance of 1m, at a height of 1.5m above present floor level.

On the under side of the Canopy the remains of a former fill of sand, gravel and rounded pebbles of gritstone can be seen to have been contented together with stalagmite, indicating that this section of the passage was at one time filled to this height with stream-borne material, upon which the stalagmite was deposited. Subsequently much of the fill was removed by water flowing in an easterly direction leaving the Canopy cantilevered out from the north wall. Flow marks in the solid rock north wall underneath the Canopy have been partially coated with a film of calcite into which a later generation of flow marks have been incised. A subsequent stage of calcite deposition then occurred, coating the remaining floor fill with a new layer of stalagmite and forming the large boss, attached to the north wall a

couple of metres beyond the Canopy, which now reaches to the floor. Finally, calcite deposition appears now to have virtually ceased, although in very wet weather a small inlet flows down the roof fissure and over the formations.

Immediately beyond the large stalagmite boss the floor falls away and the passage develops Into, a 10m high rift, and the south wall regains the familiar hade. Boulders and then large blocks of limestone (3-4m3) occupy the passage floor, still partially buried in a mud fill. Both walls of this section show vestiges of vadose meander notches, separated one above the other by a distance of some 2m. The lower one commences 2m above the boulder floor. Flow marks in both notches indicate eastward flow. As the floor falls away in a series of steps, 1-2m high, over large collapse boulders, both wall incisions extend eastward horizontally, until they might disappear out of sight, high up on the walls of the large, black, chamber that has now been reached: this is Mud Hall.

Mud Hall

Mud Hall consists of a large double chamber developed at the intersection of the Main Chamber Fault, here trending 1120/1170, and a densely jointed zone of rock which trends more to the south (1410). The size of the chamber is almost certainly due to block fall on a massive scale and the subsequent removal, by solution, of the bulk of the collapsed, shattered boulders. The southern wall of the chamber is parallel to the Main Chamber Fault and slopes out at an angle of 550 to the horizontal in its upper part, before being buried beneath a steep slope of mud, sand, clay and pebble sediments. The north wall of the chamber is also approximately parallel to the Main Chamber Fault for the first 50m but then swings away north-west, parallel with the close, packed joints, for a distance of 30m before reaching a series of tight, high, solutionally widened joint fissures. The north-eastern wall of this second half of Mud Hall is also sub-parallel to the joint trend forming a series of zig-zag buttresses for a distance of 30-40m. In this area the joint density appears to reach a maximum, with a spacing of 0.5 - 1m, and tall, tapering slabs and pinnacles of rock can be seen to be peeling away from the chamber wall.

The floor of Old East Passage abruptly falls way at the threshold of the first section of Mud Hall to form a 10-15m deep, clay and sand filled, conical pit. On looking back from the bottom of the pit, it can be seen that old East Passage occupies the roof section of a very high passage, now filled with boulders, and occasionally laminated fill of sand, clay and pebbles, which today occupies all but the top 3-4m. The stalagmite floor and formations referred to earlier have developed upon this fill and thus this first chamber of Mud Hall owes its origin to the partial removal of the fill. A narrow sloping ledge, formed on a part of the fill still adhering to the south wall, runs for 30m in an easterly direction, skirting the deep pit below. This traverse leads via a 10m descent over sloping, slippery, mud-coated ledges to a boulder-strewn ridge of dried mud which runs north/south and which divides the two parts of Mud Hall. The bottom of the pit below the first chamber may be reached by an easy walk from the ridge. Here the sectioned, laminated fill can be observed in detail. Both south and west walls of the pit are blanketed by the remains of the fill which contains layers of sand, pebbles, clay etc., but due to massive slumping, the original stratification cannot be ascertained. Much of the north wall of the pit consists of a vertical wall of solid rock with the upper PB visible in section, outcropping just below the top of the ridge.

A recent re-survey of Gaping Gill, by the Kendal Caving Club, has, for the first time, provided accurate and reliable information as to levels of passages in Gaping Gill with respect to the floor of the Main Chamber. On the basis of these figures this upper PB lies at a height of xxm above the Main Chamber floor level, compared with the xxm at a height of xxm in the north wall of the Main Chamber itself, The ridge dividing the two halves of Mud Hall is covered with a thick layer of sticky clay, now well-rounded by the passage of many cavers. The early explorers of the system noticed a considerable change in the disposition of this fill, particularly on the ridge itself, between their first and second visit. They reported: "in the Mud Chamber a surprise awaited us, for what had once" (i.e. on their first visit) "been a steep, sloping ridge of silt, like the roof of a house, was now considerable denuded, bare boulders being exposed in place of the ridge" (Cutriss 1907). The change may be due to the action of very heavy floods which occurred at the end of May, 1906, and which caused considerable changes to the floor of the Main Chamber (Horn 1906/7 p206).

Flood water may have entered from unseen passages high in the roof of Mud Hall and removed some of the fill.

East of the ridge, Mud Hall opens out to its largest dimensions. These can only be appreciated by the naked eye when the chamber is populated by a number of cavers whose lights help to give some idea of the size of the place. Normally, the absence of daylight, the liberal coating of dark-brown mud adhering to all rock surfaces, and the sheer size of the chamber, together with the height of the roof, defeats observation. From the crest of the ridge, the floor descends for a distance of 10-15m down a steep slope of dried mud, at an angle 400 before reaching a drop of 10m down the middle of a vertical rock wall. This is split from top to bottom by a vertical fissure containing calcite veining and probably represents a part of the Main Chamber Fault. At the foot of the wall the floor slopes away to the north to form a conical pit in mud and boulders, whose lowest point lies a further 10-15 m below the bottom of the wall. This is the lowest point of Mud Hall and lies 37m below the level of Old East Passage and 5m below the level of the Main Chamber floor. The Upper Porcellanous Band should outcrop in the south wall some 10m above the lowest point of Mud Hall, but it is hidden behind a steep slope of mud and boulders. To the north of the lowest point of Mud Hall the walls taper to a series of solution-widened joint fissures which can be reached by climbing up a steep mud slope. Several shale bands are displaced 20-30cm across one of the fissures, down-throwing to the east, but this may be due to settlement of the isolated buttress rather than faulting. The Upper Porcellanous Band is visible high in the roof at this point, forming a overhanging step around the full perimeter of the north side of this part of Mud Hall. No vertical displacement can be detected at this horizon. The Lower Porcellanous Band forms the roof of the deepest joint alcove.

The 10m high rock wall running along the east side of this part of Mud Hall displays an unusual set of solution features particularly on the 10m long northern part. These take the form of horizontal grooves 1-2cm apart and 1-2mm deep, extending for 5-10m over the full face of the wall. At first glance these resemble slickensides, but closer examination reveals that these are in fact shallow channels or grooves etched into the wall itself. Their origin must be due to the action of aggressive water, trapped in coarse sand layers at a time when the whole of this part of Mud Hall was being subjected to periodic flooding of such intensity that not all the water was able to drain away. As a result the chamber became an underground lake. The flood water must have contained considerable quantities of fine sediment in suspension which settled out on the chamber floor as layers of sand. Aggressive water trapped in the sand layers was able to dissolve the rock wall for a few mm before becoming saturated. The ridges between the grooves represent the horizons at which the finer clay particles settled out during the quiescent period between floods. The clay acted as a watertight seal and protected the bare rock from solution. The spacing and pattern of the laminated sediments deposited in Mud Hall under these conditions closely resembles the classic varve deposits of Scandinavian lakes. No trace of these laminated sediments now remain in Mud Hall but they must have been very similar to those still visible in Sand Cavern.

The south eastern corner of Mud Hall consists of a steep boulder slope rising from the lowest point of the floor at an angle of 450 for a total height of over 30m. Many of the boulders forming the slope are derived from the north wall, where large blocks and pinnacles of rock may be seen in the process of peeling away. One such pinnacle, occurring three-quarters of the way up the boulder slope, is formed of a single flake, of rock, 3m high, 2m wide and 1m thick. It tilts out at an angle of 300 from the vertical and appears to have moved out and down the slope some 3-4m.

A vadose meander incision is visible on the outer face with small flow marks indicating high speed flow towards Mud Hall. The Upper Porcellanous Band is visible in the north wall behind this pinnacle but no sign of it can be found in the south wall, either on the slope or in the Chamber below, although solid rock is visible in this wall for at least 20m vertically below the level of outcrop in the north wall. The upper Porcellanous Band can be traced around the whole of the north side of Mud Hall as far as the ridge, displaying an apparent dip of 1-1.50 down to the east, thus reversing the trend seen in the Main Chamber.

The main axis of the Mud Hall boulder slope trends 1120, but the south wall remains parallel to the Main Chamber Fault. This is confirmed by the fact that the roof

over the boulder slope, near its summit, dips south at the characteristic 550 angle. A series of high avens are visible in the roof over the upper portion of the boulder slope. The first occurs three quarters of the way up, aligned along the 1020 trend of the Main Chamber Fault. Near the summit of the slope the passage, still rising steeply, measures 15m high by 15m wide. At this point a small inlet stream enters from another high aven, and is slowly clearing the mud from the boulders in its vicinity. Several of the clean-washed boulders have large slabs of broken calcite still adhering to their surfaces. It is not clear whether the boulders have fallen from the roof, or whether they are the remains of calcite floor deposits formed below the aven, and which have been subsequently destroyed by down-slope rock movement. In very wet weather a considerable stream enters from this aven. Its source is unknown and it sinks in the boulder floor. It probably enters Mud Henslers Passage (see below). Beyond this inlet aven the Main Passage, known as Far East Passage, swings east (920) and the floor levels off.

Far East Passage

Far East Passage leads east from Mud Hall, commencing at the top of the boulder slope. The passage is floored with a thick layer of well-trodden sticky mud, which slopes down across the passages from north to south. At the foot of the south wall several small mud-choked tubes end among large boulders. The south wall over-hangs, sloping south as in Old East Passage, and is an indication of the continuing presence of the Main Chamber Fault. 5m further on a second large inlet aven is visible in the roof, rising for at least 20-30m. The aven is now dry, but a sizeable stream must have entered here at some time in the past since directly below the aven much of the mud floor has been removed. This former stream sank at the foot of the south wall, excavating another set of small passages among large boulders buried in the mud, and jammed against the south wall. A slippery climb down mud blocks descends a further 5-7m, trending west, i.e. back towards Mud Hall. At the foot of the climb some 15m below floor level in Far East Passage, the tight rift turns south, levels off and abruptly assumes an oval cross-section, one metre in diameter, and half-full of mud and water. This is Mud Hensler's Passage, one of several tributaries to Hensler's Stream Passage which are developed on the upper surface of the upper Porcellanous Band. A short distance beyond the entrance climb to Mud Henslers Passage, the floor of Far East Passage rises up a 10m high mound of mud and pebbles, coated with stalagmite, which reaches to within 1m of the roof. The remains of two stalagmite sealed layers of fill can be seen adhering to the walls above the sloping floor. The passage assumes a triangular cross-section with a 1m wide fractured flat roof at the apex. Above the projecting ledges of cemented fill, vestiges of two distinct levels of vadose incision, one 3m above the other, are visible on the passage walls, before disappearing under the rising floor deposits. Flow marks averaging 5cm diameter, at both levels, indicate a former eastward flow of water. Beyond the apex of the mound the floor drops away as the passage enters the next chamber. Immediately beyond the narrow aperture at the top of the mound of fill, a stalagmite coated joint fissure in the north wall runs back to a choke.

The whole of this next chamber, known both as Boulder Chamber and as Avalanche Pot Chamber, is developed along the line of this joint which trends 1220/3020. The floor of Boulder Chamber consists of a steep mud and boulder slope dipping south from a narrow ledge against the north wall down to several deep holes in the floor, amongst large boulders close to the south wall. Above these, the roof lifts at a high aven which rises out of sight. A steady trickle of water normally enters here, but in wet weather, this increases to form a considerable size waterfall. The aven, now known as Avalanche Inlet, was recently scaled by members of the Imperial College Caving Club. It proved to be 18m high, and led via a tight 40m phreatic tube with a narrow vadose slot in the floor to a further aven 25m high. This in turn was connected to the base of yet another aven, 30m high by an east trending fault controlled stream passage, with shale bands displacement indicating a vertical throw of 1.5m down to the south. A calcite choked bedding plane with a strong draught prevented further progress. The furthest point reached appears from the survey and radio location tests to be under a slight mound, in the middle of a peat bog, some 100m south of Grange Rigg pot, and only 3m below the surface. No plan of Avalanche Inlet has yet been published but from discussions with the original explorers it appears to ascend almost vertically, probably

still within the plane of the Main Chamber Fault. This supposition is corroborated by the fault seen between the second and third shafts.

Avalanche Pot

A crawl down to the boulders at the bottom of the pit in the floor of Boulder Chamber leads to a narrow stream passage which has been developed by the water descending Avalanche Inlet. This passage leads to a dry shaft descending in two steps, each of 8m and which ends in a boulder choke. Near the head of the first shaft the original explorers reported seeing "a band of porcelain limestone' (ref. Brindle 1951), which may be the upper Porcellanous Band. At the bottom of the second shaft a narrow fissure leads east to a further drop of 2m. This ends in a narrow crack, too tight to enter, from which the noise of running water can be heard. On the opposite wall, a narrow crack, enlarged by a sledge hammer, leads to the head of a third shaft, 33m deep. Although tight at the top, the shaft widens out lower down into a spacious rift At the bottom, a bridge of shattered rock separates two holes leading to a small pool of water fed by a stream entering from a low bedding plane. The pool outflow drops down a narrow rift and disappears down a fourth shaft. The original explorers reported that a loud roaring sound could be heard from this fourth shaft. The narrow fissure leading to this fourth shaft proved too tight to enter despite many attempts over the years and it remains unexplored. The walls of the 33m shaft were found to be very loose and original exploration was greatly hindered by flakes of rock falling without apparent cause on to those waiting at the bottom. Hence the name 'Avalanche Pot' This has no doubt deterred further investigation of the system. The only existing survey can be seen in Grainger's 1968 version. From this it would appear that the Avalanche Pot system is developed in the plane of the Main Chamber Fault slightly to the south of Far East Passage and runs eastward, terminating under Brothers Junction.

Brothers Junction

Beyond the pit in the floor, Boulder Chamber changes Its shape and become low and flat-roofed. The overhanging south roof feature is left behind at Avalanche Inlet. Vadose meander notches, with flow marks indicating flow in an easterly direction, are visible in places on both walls. The floor of mud rises almost to the roof and several sand-choked holes, among large boulders, appear close to the north wall. Boulder Chamber ends at a low, narrow crawl over a floor of calcite covering the mud Here the passage changes direction from its previous trend of 1120, swinging to 1220, and the floor drops suddenly, at the start of Brothers Junction Chamber. A 10m long, 2m2 solid block of limestone. which has dropped out of the roof some 2m above, occupies the middle of the chamber floor. Beyond, the roof assumes a gothic arch cross-section and runs east for a further 50m, until the walls converge to form a narrow v-shaped alcove. From this point a floor level bedding plane crawl, which occasionally draughts strongly in an eastward direction, leads to a narrow aven which rises 2m before becoming too tight. At this point, a bedding plane, 10cm high opens in the north wall. Audible connection has been established through this bedding plane with a low branch passage near the end of North Craven Passage, in Car Pot. This point marks the most easterly extension of the Main Chamber Fault so far discovered in Gaping Gill.

Whitsun Series

The Whitsun Series commences where the main phreatic tube forming the northern end of Far East Stream Passage leaves the latter at a 1m high mud step, swinging south-east and dipping into a partially mud-choked alcove. At the back of the alcove a mud slot drops through the floor for a distance of 1m in a continuation of the main phreatic tube, trending 1400 guided by a series of major joints and sloping down at an angle of 50. The walls of this passage are covered with large (10-20cm diameter) sharply incised flow-marks indicating former flow in a south-easterly direction. The floor consists of a dry, caked mud. Pool Passage leads for some 30m into a phreatic domed chamber with solutionally widened joint fissures in the roof. The mud floor levels off and seals the main passage at the back of the chamber. In the centre of the chamber floor a small hole drips 2m through large boulders embedded in the mud into a 1m diameter horizontal tube, formed along the same joint line. The floor of the tube is presently occupied by a 50cm deep canal of water, the lower half of which consists of liquid mud. A well-defined former water level is visible on the walls and in places the roof lowers below this level.

During the early explorations by the members of the Yorkshire Ramblers Club the water level in this passage was found to be at this upper level indicated by the tide marks and the passage appeared to be an impenetrable siphon.

During one of the early post-war Winch Meets the water level was lowered by hand pump to its present level. This revealed a further 10m of canal passage, terminated by a small 2m high dome-shaped chamber with a solid rock roof and no apparent outlet. In 1967, a mud-sealed boulder choke on the far side of the dome chamber was excavated at roof level and an ascending squeeze now leads into a 2m high 7m long phreatic joint chamber. Beyond, a bedding plane crawl leads directly into a second phreatic joint chamber, 7m long and 4m high known as the Baptistery. Both chambers contain holes in the floor occupied by static pools of water. One of the holes in the floor of the Baptistery leads to the Font. This consists of a 4m long, water filled, bedding plane crawl running south, 2m below floor level. This was excavated in 1968 by members of the Bradford Pothole Club during their Whitsun Winch Meet. This resulted in the water level being lowered sufficiently, except in very wet weather, to allow the crawl to be negotiated, preferably on one's back, since the 50cm deep pool of liquid mud reaches to within a few cm to the roof. The strong current of air normally flows from the passages beyond into the Baptistry whenever the water level in the Font is low enough. At the southern end of this wet bedding plane crawl the passage rises sharply and the 2m vertical squeeze between the rock wall and a mud bank leads into a much larger passage, running south-east for 60m. This passage, known as Straw Gallery, is some 5m wide and has a 5m high, arched, roof. The floor consists of mud in places, gravel in others and 1m high mud-banks lie against the side walls. In the middle of the chamber a group of extraordinary 2-2.5m long straw stalactites have developed below roof joints and nearly meet the floor. A small stream occupies a narrow channel cut in the floor deposit, flowing from the south-eastern end of the chamber and sinks into a small passage at floor level at the base of the West wall at the north-western end of the chamber. The stream may be followed into a low, muddy, crawl in a south-westerly direction at right- angles to the Straw Gallery to a pool with limited air space.

A tight squeeze under the left wall at this point leads into the first of three interconnected avens, formed along the joint parallel to that seen in the Straw Gallery. The centre aven of the three is the highest, rising approximately 15m. At its base a 1m high passage leads downhill in a westerly direction. This leads into a low bedding plane passage with a dried mud floor. After 40m a steep mud slope leads to a very tight bedding plane choked with stalagmite. At the north-western end of Straw Gallery the main passage disappears below the level of the rising mud floor, a few metres beyond the slot leading to the Font. Close to the left hand wall and the old stream sink a narrow, low passage leads for 20m before becoming choked with soft white calcite clay. This choke has been partially excavated and the passage now terminates in a pool of mud and water which lies at the same level as Terminal Chamber in Far South East Passage and less than 30m to the south-east of it. At the southeastern end of Straw Gallery the roof lowers and the floor rises to within 1.5m of each other. The roof immediately lifts again ahead, this point forming a small chamber. A small stream enters the chamber from a joint fissure in the roof and flows north-west into Straw Gallery. Lying on the floor of Drip Chamber a number of large blocks of crumbling coarsely crystalline, partly corroded stalagmite bear witness to the aggressive nature of the water entering. At the far side of Drip Chamber the floor rises to within 1m of the roof at a vertical mud wall in which sand and clay laminations are visible in section. In places a thick layer of stalagmite caps the deposits. Beyond Drip Chamber a 10m long crawl leads forward over the mud fill to a T-junction. The floor fill has been trenched by a stream which formerly entered from the right hand branch and sank in a tight slot a short distance along the left hand branch at the far wall. The stream-bed can be followed for 10-15m the right along a narrow meandering crawl to a small inlet aven partially choked with calcite. This usually emits a strong cold current of air, hence the name Wind or Draughty Aven. The left hand branch at the T-junction rises steeply up a mud slope beyond the narrow slot marking the side of the former stream sink. This leads into a continuation of the main phreatic tube, now nearly filled to the roof with mud, caked with a 1 m deep layer of fine white sand. The main passage appears to have abruptly changed direction at the T-junction and now

trends 1100.

A few metres along the crawl the floor close to the right hand wall drops very sharply, forming a steep 5m high mud slope leading to a boulder floored rift passage aligned north-south. The right hand branch of which slopes steeply down in a northerly direction ending beneath the main phreatic tube in a choke of shattered rock through which a small trickle of water sinks. To the south the left hand branch rises steeply over jammed boulders and emerges under the side wall of a narrow high joint chamber, originated 133/3130, known as Bradford Canyon. The walls of the chamber rise vertically for 20m and a narrow meandering vadose inlet is visible high up in the roof at the south end. A cool current of air normally descends from the highest point of the chamber and a small stream enters from a point 10m up the south-easterly end. The stream inlet passage has been investigated with the aid of scaling poles and the stream followed up a narrow meandering crawl which runs approximately south for some 70m rising steeply. The major inlet passage visible high in the roof has not been investigated. A 10m long crawl in a white-sand filled bedding plane leads past Bradford Canyon into the continuation of the main phreatic trunk, known as Anagram Passage. This runs for 160m in a south-easterly direction (trending between 1400 and 1500) in a 3-4m wide passage whose floor is covered with sand and whose arched roof rises between 1 - 1.5m above the floor. Large, clear flow marks indicating south-easterly flow are visible in the roof. Narrow solutionally widened joint alcoves cross the passage at distances from 1-3m apart. The majority of these are aligned 135/3050. Each cross joint is decorated with a fine collection of heiictites and short straw stalactites. Many of the latter possess a transparent triangular lateral flag near the tip aligned with the passage, presumably developed as a result of the appreciable current of cold air which normally flows south-east along the main passage. At Rhubarb Corner the passage swings east and becomes lower, running across the predominant joint direction for a further 100m. High and low sections alternate as each cross joint solution alcove is reached. A further flat out crawl section leads to a major passage running south-east.

The major passage encountered at the T-junction commences 30m to the left, i.e. to the north-west, as a tight joint passage which closes at floor level. A narrow eye hole, 3m above floor level, possibly leads to a further chamber beyond. This has not yet been investigated. South-east of this point, joint control passage extends for 10m over a rock bridge to a construction. A further 20m long section of joint passage is decorated with gour pools and mud formations. This section is known as Dogtooth Inlet. The passage widens beyond the point of entry from Anagram Crawl and is initially 7m wide, 5m high with large sand/mud banks on either side of a sizeable dry stream gully, cut in the floor. The floor gully deepens rapidly and the mud banks rise to the broad, arched, roof until eventually the stream channel enters a 10m deep narrow crack, running along the line of the passage and connecting through a bedding window with a fine, 3m diameter, vertical, circular shaft, the walls of which rise up out of sight. A small inlet stream descends from the aven known as the Pit. The dry stream channel in the floor of the main passage enters the pit at its base. The small stream inlet descending the aven has sectioned the fill in the main passage forming a 4m high wall of graded sediments ranging from fine sand and silt at the top, to gravels and pebbles and to visible water-warn boulders at the base of the section. A few metres beyond the pit a second aven pierces the roof of the main passage, rising 7m to a low crawl entering at roof level. Below, the floor is littered with clean washed rocks. 20m beyond this second aven the roof of the main passage again lifts, forming a dome-shaped chamber known as Hollow Mountain Chamber, so named after a large, sloping sheet of thin calcite had formed on a sand bank, which subsequently was removed.

On the far corner of Hollow Mountain Chamber yet another aven rises 10m to the low bedding inlet. The floor of the main passage rises gently until a major cross joint passage bearing 20/2000 is reached after a further 30m. The floor of this cross passage is occupied by a small stream which emerges as a spout of water issuing out of the small fissure in the rock wall. After falling into a natural rock basin the stream flows north across the main gallery, trenching the floor deposits until it enters a 2m high passage, running north along the joint beyond and below the north wall of the main passage. After two small meanders the stream finally sinks in boulders in the floor, but the passage continues as a muddy climb which leads into the base of a joint aven over

20m high and containing many fine formations.

The main passage continues south-east beyond the cross joint as a low crawl over mud with a noticeable current of air flowing towards the south-east. The crawl passes the base of an aven choked with rounded gritstone boulders. Beyond this point a choice of routes at different levels among boulders leads after 10m to the head of a 10m high boulder slope which falls away at the entrance of a large chamber, 10m high, 10m wide and 50m long. This is known as Line Chamber. At the far end of the chamber the floor rises gently over a slope of flow-stone decorated with a line of calcite columns up the middle with corresponding stalactite formations along the line of a conspicuous joint which is visible running along the middle of the chamber roof. The joint is orientated 140/3220. A second, smaller, chamber known as Farrer Hall may be entered via a gully along the left wall which is found beyond the pile of fill occupying the south-eastern end of Line Chamber. Here a small stream flows south and north emerging from a wide low passage, choked with stalagmite and boulders and sinking among large blocks close to the north wall. A number of excavations have been made in Farrer Hall with a view to extending the system, but as yet no success has been achieved.

West Chamber

West Chamber is reached by ascending the west slope of the main chamber. At the top of the boulder slope a 3m high rock step leads into a flat-roofed bedding plane passage, 1m high, 2m wide. For part of its length the eastern side has fallen away into the main chamber. Water worn sand stone pebbles and boulders, well-cemented with stalagmite cover the floor and choke both western and northern ends. The floor slopes gently to the south- east as a small vadose trench cuts through the floor deposits, heading south-east towards West Chamber. The roof of this bedding passage is for the most part small and flat in several places joint control solution tubes are visible. It is possible this bedding plane may be one of Schwarzacher's master bedding planes, occurring some 7m above the upper PB and xx m above the floor of the Main Chamber. This particular bedding plane appears to have played an important role in the development of parts within the Gaping Gill system. In particular it can be seen to be a favourable horizon for the development of large phreatic tubes not only in West Chamber but in East Passage, South East Passage, Sand Cavern and Stream Chamber.

As West Chamber is approached, 10m after entering the bedding plane the roof levels along a main joint 150/3300) and flowstone curtains cover the west wall. Several 1m high stalagmite columns occupy the floor of the stream trench ending abruptly into a 5m drop into West Chamber. Above and beyond it is possible to traverse out at master bedding plane level for a further 3m. From this position it is clear that the primary phreatic development in this vicinity occurred along the line of intersection of the joint and the bedding plane. Traces of this initial phreatic passage can be seen to continue across West Chamber at high level, in the form of remnant ledges on the chamber walls. At the south-eastern end of West Chamber both phreatic tube and vadose trench continue as the passage known as Pool Traverse (see below).

At the foot of the 5m drop into West Chamber itself it can be seen that the approach passage has been trenched to a depth of at least 7m and subsequently almost completely filled with a mixture of boulders, pebbles and gravel, capped with a thick layer of stalagmite. At the foot of the descent into West Chamber the floor is covered with large angular blocks of limestone, which appear to have fallen from the chamber walls. A conical pit in these boulders at the foot of the descent into the chamber suggests that from time to time the Main Chamber floods to a sufficient depth to allow overflow water to enter West Chamber via the bedding plane entrance crawl. Beyond the pit the floor rises over mud-coloured boulders and then slopes away in all directions as West Chamber achieves its maximum width of 2m. The east wall of West Chamber is approximately vertical and the line of small mud choked sinks has developed along its foot. In contrast the west wall overhangs the chamber floor for most of its length. A low horizontal extension has developed under the overhang, at the back of which the upper PB is exposed as a 60cm thick bed forming a prominent down step in the overhanging roof 1m above floor level. Below, the mud floor slopes steeply away to the west in a number of discrete sinks each containing quantities of water-warn debris.

This includes caving litter (flash bulbs, carbide tins etc.) and is evidence of relatively recent flooding of the floor of West Chamber. At the south-eastern end of West Chamber the walls converge to form a semi-circular alcove, here close to the east wall and along the line of the main joint noted at the entrance to West Chamber. A series of rising phreatic tubes, strongly flow-marked in an upward direction, lead to an oval phreatic window, the start of Pool Traverse, at the same level as the master bedding plane observes at the head of West Slope.

Pool Traverse

Pool Traverse forms part of the former joint guided phreatic tube, running south-east, 150-3300, from the west end of the Main Chamber and which has been isolated from its northern part by the development of West Chamber. Pool Traverse, for the first few meters from an oval window overlooking West Chamber, consists of an oval phreatic tube whose long axis is vertical and possessing holes in the floor connecting back down into West Chamber. Beyond, the passage widens and ledges appear on both sides at bedding plane level. The floor, initially of solid rock, rises over a mount of boulders and then commences to fall again as a narrow vadose trench develops. After some 30m the floor drops vertically a distance of 5m into a long static pool. The roof over most of Pool Traverse shows solution-widened joint tubes, rising 1-2 m above master bedding plane level. Directly above the highest point of the mount of boulders on the floor, a 1-3m oval hole rises 5m into a small high level chamber. This has formed as a result of the collapse of the floor of a higher level joint-guided phreatic tube into Pool Traverse. The high level tube can be seen to be completely filled with dark sticky mud, except where the local collapse has occurred.

Pool Chamber

At the end of the pool traverse, directly above the 5m drop to the pool itself mentioned above, the roof rises some 5m before narrowing to a series of narrow, parallel, joint fissures. The traverse level itself can be traced out over the pool some 5m above water level as a series of rounded ledges. The pool itself is some 30m long and no more than 1m wide above water level. The depth of water for the first 10m varies between one and 1.5m and below the water level the passage widens by 2-3m. Several large boulders occur under water in the middle of the pool. Beyond these the water shallows rapidly until at its end it is no more than 10cm deep with a further 10cm of sticky mud at the bottom. 1m above water level at the south-east end of the pool a 2m diameter vadose notch has been incised in the walls. Small, sharp flow-marks here indicate high velocity in flow in a south-easterly direction.

Beyond the pool, the passage walls swing away to form an oval chamber, Pool Chamber, 2-3m wide, between 15 and 20m high and 30m long. The chamber floor is occupied by a low mount of mud covered boulders which form a dam continuing the water in the pool. A long axis of the chamber lies along the same joint line 150/3300, first seen at the approach to West Chamber. It rises to its highest point at its south-easterly end where inlet avens can be seen partially choked by massive calcite deposits. In the middle of the north-east wall of the chamber a low crawl runs north-east from a descending squeeze known as the Portcullis. This was found to be choked by mud and boulders on the first exploration of Booth-Parsons Passage and the connection to Pool Chamber was excavated on that occasion.

At the south-eastern end of Pool Chamber two passages lead off at floor level, that on the left climbs over the jammed boulder bridge and immediately drops into a low, wide bedding chamber half-full of a static pool of clear water which appears to have developed within the thickness of the upper PB, since this rock is visible on both the floor and the roof. The window on the right at the edge of the water leads through into the second major exit passage, known as South Passage. It is here referred to as South Passage II to avoid confusion with the passage of the same name, here referred to as South Passage I, which links the Main Chamber and Pool Chamber via South Boulder and the Portcullis. In order to understand the origins and sections of development of passage beyond Pool Chamber it is necessary to first describe South Passage I and the Booth-Parsons Crawl.

South Passage 1

South Passage 1 commences as a descending keyhole-shaped passage running south-west from immediately above and behind South Boulder in the Main Chamber. Above the entrance the south wall

of the Main Chamber hades up towards the north. A 50cm. diameter half tube is visible, widening down the last 10m of this hanging roof. It enters South Passage 1 and levels off, forming the roof of South Passage 1. Immediately inside the entrance of South Passage 1 the PB is visible in section below the roof tube in the east wall. Initially it dips south parallel to the hanging roof of the Main Chamber but levels off after 2-3m This section of the upper PB shows many major fractures which are filled with large, clear, crystals of calcite cement.

The first section of South Passage 1 proper consists of a low arched tunnel of phreatic origin, with a solid rock roof. The floor is covered with an apparently unsorted mixture of mud, clay, sand, water-worn gritstone pebbles and an occasional large, angular block of limestone. In places the upper PB is visible in section in the walls, in other places it forms ledges projecting at both sides, but for the most part it is blanketed by the floor fill, sloping up to reach the roof 7m along the passage from the entrance, calcite-cemented ledges of fill project from the side walls. These give evidence of at least two distinct stages of fill separated by a layer of stalagmite. The low fill consists of 12-20cm diameter water-worn pebbles and boulders, on the other hand the upper fill contains mainly gravel or laminated sand and clay layers. Flow markings along this first section of passage are clearly visible in the roof and range in size from 1-2cm diameter near the Main Chamber to 3-6cm diameter 10m along the passage, all indicating a southward flow of water.

Ten metres from the entrance of the first of the series a major joint crosses the passage almost at right angles. All joints trend 142/3220. At each cross joint, phreatic solution, enhanced by mixing corrosion has resulted in extensive upward solution and the formation of a series of small chambers, the roofs of which display a wide variety of solution pockets and tubes. The heights of these chambers vary from 2-10m above the top surface of the upper PB (see Fig. xx for spacing and heights of individual chambers). The floor fill tends to thicken under each cross-joint forming a slight ridge 5-10cm high. At Cross-joint 2, a section of fill is visible in the tapering alcove at the north end and consists of clay and sand layers overlying, and separated from, a coarse gravel layer by a 6m thick sheet of stalagmite. At Cross-joint 3 chamber holes in the mud fill covering the floor and which has resulted from erosion of the fill by cavers, reveals that the fill rests directly upon the upper surface of the upper PB. At Cross-joints 6 and 7 South Passage 1 turns and runs along the line of the joints for 3-4 m then swings back north-east down a low, wide boulder floored crawl. This is the southern end of Booth-Parsons Crawl.

South Passage 1 continues in a southerly direction beyond this junction, beyond two further cross joint chambers spaced close together. The passage floor rises gently and the flow-marks here, indicate a reversal of the former flow direction, i.e. northward into Booth-Parsons Crawl. After a further 5m another junction is reached. To the left a 1m slope drops into a low waterlogged, static pool which is that already referred to in the section on Pool Chamber. To the right the passage continues for a further 10m as a low crawl over a pebble and mud floor and ends at the upward squeeze of the Portcullis leading into Pool Chamber. Small flow marks on the roof of this last section also indicate a northward flow, i.e. from Pool Chamber towards Booth-Parsons Passage.

Booth-Parsons Crawl

The Booth-Parsons Crawl was one of the earliest side passages discovered during the original exploration of Old East Passage (Ref. Horn, 1906/7, pp 202). It commences at the south-east corner of the first joint chamber in Old East Passage where the mud floor slopes away along the line of the joint, below the overhanging south wall. An easy climb through boulders descends 5m onto the top of the large sloping boulder which projects at roof level into a chamber below. The floor of the chamber is reached by an overhanging descend of 7m The chamber measures 3m in width by 10m long, by 7m high with small clean-washed walls rising vertically from a sloping dry mud floor to big solution pockets in the roof. A small inlet tube is visible high in the roof in the south-east corner and the chamber itself lies on the same joint visible in Old East Passage (142/3220) Two-thirds of the way along the right hand wall a large, steeply dipping, mud floored, phreatic tube descends for a distance of 10m before levelling off. Beyond, three passages leave the small chamber in which the upper PB is visible in section at floor level. The left hand branch runs for some 20m in a south-westerly direction and

consists of a 1m high, 1-2m wide low crawl over a floor of sand and mud. After passing two small tubes leading off to the right. This branch becomes lower and wider and appears to choke at the limit of vision. On the floor the dried, partially decayed, remains of a number of fence-posts lie scattered, apparently brought in by flood water which has left many small straw stalagmites on the passage roof clogged with strands of grass, heather etc.

Back at the junction the right-hand passage narrows to a tight crack after 1m, but it must connect via apertures in the boulder slope with the Main Chamber, since from this point the sound of the waterfall and winch whistle signals can be clearly heard. The centre passage is the largest of the three and runs for some 30-40m as a 1-1.5m high, 2m wide, low arched crawl over a floor of rounded pebbles of gritstone and limestone. Two small tubes enter from the left after 20m. These link with the first left hand branch passage. In this vicinity small projecting ledges of calcite-cemented fill, project from the walls close to the roof level. Beyond, the passage continues passing a series of small cross-joint alcoves and reaches after a further 20m a large cross-joint chamber. This is some 10m long, 2m wide and its roof tapers to a series of large solution pockets at a height of 10m. A perceptible current of air enters at the right hand (north-western end) where one large solution pocket rises out of sight. Below this, inscribed on the wall is the legend 'Plus 50 feet BPC 1950'. The Main Chamber waterfall is also audible at this point, The passage continues a further 20-25m passing five more cross-joint chambers of varying sizes, at intervals of 5-10m. An air current descends at least one of them and the Main Chamber waterfall is audible most of the way along this section. The floor commences to rise gently, the roof lowers and the size of boulder on the floor increases until the passage emerges abruptly into a wider, higher section which swings right, rises more steeply and joins South Passage, halfway to Pool Chamber. At the point of where the passage changes direction, a low oval slot is visible in the left hand wall. This is the start of Hensler's Long Crawl.

South Passage II

South Passage II runs in a generally south-westerly direction from the south-west end of Pool Chamber for a distance of approximately 150m to a T-junction. For many of its length it takes the form of a 2-3m diameter circular, or oval phreatic tube with a shallow square-cut into the floor, cut into the upper surface of the upper PB. For the first 10m it runs along the 1420 joint line of Pool Chamber. Immediately after passing a window on the left which leads down over boulders to the low, part water filled, bedding cave, it swings right for 20m descending 1-2m. In the middle of this section the roof exhibits an unusually smooth, flat, feature, usually associated with passages containing water rising to within a few cm of the roof. Beyond this section the passage swings left again for a further 40-50m guided by twin joints in the roof, trending 148/1500 which are clearly marked by lines of solution pockets.

The passage again commences to swing right and a further section of flat roof is well-displayed on the bend and beyond. The final section of the passage heads south-west for a distance of approximately 50m, passing five major joints trending 146/1480 and which has resulted in the development of cross-joint chambers 4-5m high and wide, an outstanding development of solution of pockets in the roof. Over its whole length the floor of the passage consists of hard, dry, sand with remains of a cracked, dried mud, coating visible in places against the walls. Near the start of the last section a group of large angular limestone boulders project through the floor sediments. One of these is covered with a 1-5m diameter boss of stalagmite now half-buried in the sand and lying on its side. As T-junction is approached the floor rises 1.5m and South Passage II emerges into South East Passage proper. The passage to the right leads to Sand Cavern, that to the left to South East and Bar Pots.

The upper PB is visible in the walls of South Passage II at four separate locations close to floor level. The upper surface of this bed was very carefully levelled from Pool Chamber through South Passage II to Sand Cavern. The results indicate that South Passage II itself is developed along the strike of the PB, the change in level from one end to the other being less than 0.3m. From T-Junction into Sand Cavern, however, the bed rises steeply by some 2m over a distance of 60m. It appears to be dipping south/south-east at approximately the same angle as the exposure visible on the South Wall of the Main Chamber. Few clear flow-

marks are visible in South Passage II and many of these appear to be associated with anomalous turbulence occurring in the proximity of the Crossjoint Solution Chambers and give conflicting evidence of flow direction. On the whole, the flow-marks appear to indicate a former flow in a south/southwesterly direction, i.e. from Pool Chamber towards T-Junction.

T-Junction to Sand Cavern

At the end of South Passage II the floor rises steeply some 30-60cm over a dry mud, and the roof lifts as a smaller but slightly higher passage is entered. This is South East Passage running from the northern end of Sand Cavern to South East Pot. The section between T-Junction and Sand Cavern is some 60 m in length, running almost straight in a northwesterly direction. Over much of its length it consists of a flat, mud-floored, phreatic tube, some 1-2m wide with an arched roof rising to a maximum height of 1m. In several places smooth surfaces are developed at the highest point of the roof, resembling those seen in South Passage II, but developed at a slightly higher level. Over much of its length flowmarks averaging 2-4cm diameter are well-developed, indicating former flow in a southeasterly direction. Towards the end of the passage, however, the mud floor falls away gently, revealing a lower set of flowmarks in the walls whose average diameter is of the order of 1cm. This indicates a second flow regime of much higher velocity water, also moving southeast. For the first few metres to the northwest of T-Junction many of the steep upstream edges of the large flowmarks exhibit white impact marks which suggest a much later high velocity flow of water in the reversed direction, i.e. towards the northwest, capable of moving pebbles and small boulders at sufficient speed as to cause the impact marks. At the end of this section of passage the floor drops away sharply as the passage enters a much larger chamber. At this point the PB is well developed as a rock ledge on the right-hand side of the passage.

Sand Caverns

The chamber now entered forms the northern end of a long, large passage known as Sand Cavern. At the point of entry it is 2-3m high, some 10m wide and almost completely occupied by a large bank of sand and cobble fill, sloping down from left to right. At the northern most end the roof dips steeply above a steep slope of fill forming a small tube which descends over a distance of about 10m before being almost completely choked by fill. This passage known as "D1" has been excavated from time to time over a period of many years without result. A gentle air current is usually discernable at the bottom and reports have been made that in wet weather the sound of a waterfall is sometimes audible at this point. To the left of the point of entry the floor rises steeply over a large mound of fill occupying the centre of the chamber. The continuation of the high speed flow mark section noted at the end of the approach passage can be traced around the wall before it disappears below the fill on the northwest side of the chamber. After 10m the roof lifts abruptly, where repair of joints trending 1430 and the small rocky tube forming the alternative entrance to the chamber enters the middle of the chamber at ledge level and clearly developed on the PB in the first instance, but subsequently trending through it. across the chamber obliquely and mixing solution, has resulted in upward development along the joints to a height of 7-10m.

Beyond this point the passage floor levels off and the roof rises steadily until reaching a height of some 10m. This section of the chamber is some 40m long and varies in width from 5-10m. In the roof, traces of a 5m diameter phreatic half tube are discernable, developed above the prominent bedding plane which lies some 7m above the PB. Below the bedding plane the walls of the passage are approximately vertical and are visible beneath the extensive cover of sand. The rock appears highly jointed and a considerable amount of collapse has occurred with flakes and pinnacles peeling away from the walls. The whole of the section of passage trends southwest at approximately 210-2200. After 40m a sharp bend to the left occurs and the roof lifts abruptly as the main chamber of Sand Cavern is beyond. The roof itself exhibits very close jointing to a degree which may be said to approach the fracturing associated with faulting, and over much of the roof, which now rises to a height of 15-20m above the floor, thin white streaks of calcite have developed along the joints/fractures which here trend 1330. The chamber itself is some 50m long, varying in width from 10-20m and the mud floor littered with large fallen blocks drops steadily away to the centre of the chamber before rising again towards the far

end. Deep pits fall steeply away in two places. Firstly against the west wall at a point about one third along the chamber and again against the east wall of the chamber at the far end.

At the base of both these pits the PB is visible in the wall. The bedding plane and phreatic half tube, first seen in the previous section of the passage, are particularly prominent over the full length of this chamber. Two passages enter as windows at this horizon in the west wall. These both connect with a complex series of tight mud-filled joint passages developed to the west of Sand Cavern and which lead to the "Great Fissure" passage leading out of Stream Chamber. At the southern end of the chamber the floor rises steeply over a series of very large collapse boulders coated by a thick layer of sticky clay. The chamber terminates in the 3m high vertical wall of horizontally bedded, laminated sediment, with alternate layers of dark-brown sticky clay, which rises to within 1m of the roof. Looking north from the base of this wall of laminated sediment it is clear that the whole of this section of Sand Cavern has been at some time filled at least to the level of the major bedding plane with this sediment, which has subsequently been removed by water entering from the two windows mentioned earlier and which flowed north through the whole of Sand Cavern, and then southeast along South East Passage. At some subsequent stage the choked passage D1 became the route by which water and sediment left Sand Cavern. The clearance of the fill then eased when water no longer entered via the window passages. Slow sapping of the remaining sediments from below then created the two pits in the floor. The original course for the major fill and the route by which it entered Sand Cavern is not known, but it may well lie still buried beneath and to the south of the laminated sand wall.

Stalagmite Chamber

A 2m climb up the right hand side of the laminated sand wall at the south end of Sand Cavern leads to, via a hands and knees crawl, a small solution joint chamber running south for some 3m before the mud floor meets the roof along the line of the joint. A low arch on the right at the commencement of the chambers leads immediately to a larger chamber whose floor consists of a steep bank of dried mud sloping down from left to right. This is Stalagmite Chamber, so called by members of the Yorkshire Ramblers Club from the wealth of straw stalactites and helictites adorning the roof. Today, however, little remains of this adornment due largely to the innumerable visitors to this part of the system over the years. At the lowest point in the floor a narrow slot leads to a vadose trench in solid rock which leads to the right in a northerly direction to a complex of joint fissures passages connecting with the two windows over-looking Sand Cavern. To the left the trench swings west then northwest and enters a large chamber containing a chaotic pile of huge collapsed boulders.

Across Stalagmite Chamber directly opposite the point of entry a climb up a steeply sloping mud bank leads via a small window at roof level to a second large chamber whose floor is largely occupied by a cone of dried mud sloping down from south to north. The most notable feature of this chamber is the large number of 0.5 to 1m high stalagmites which have developed on the mud. Many of these, however, have been removed or displaced by careless cavers. Stalagmite Chamber has two exits. The first may be found by crawling round the mud bank keeping left until at the most southerly point a low crawl leads into a joint control phreatic passage. Initially the floor rises steeply to a partial boulder choke. Beyond this a small high joint chamber is reached with a boulder choke aven above and to the side. A small hole excavated in the mud floor at the end of the chamber leads directly to an 18m deep shaft, Queensbury Pot. The shaft leads past a massive hanging block the size of a grand piano, wedged across the rift into a boulder-floored chamber developed along the same joint. A tight descending hole excavated among the boulders in the floor of the chamber leads to a streamway, Kingstreet, which ends in an aven upstream and leads to a 3m climb down stream before becoming too tight. The hole in the side of this latter climb leads to a 6m pitch which may be bypassed by a climb down loose rock on the left. This leads to Bridle Chamber with no apparent exit apart from a boulder choked aven.

(In 1987 E E Whitaker et al excavated a fissure near the top of Queensbury Pot and discovered a series of high avens, Queensbury Avens. Ref. CPC Record 8, Oct 1987)

Stream Chamber

Stream Chamber is the name given to a very large chamber/passage developed along a major line of faulting which trends approximately 110/2900 for a total distance of approximately 400m in a north-westerly direction from Stalagmite Chamber. It may be entered from the narrow vadose trench which runs along the north side of both Stalagmite and Stalactite Chambers, which connect with the trench via narrow slots at the lowest point of the mud floor in each chamber. The third entry is made through a low crawl on the west side of Stalactite Chamber to the north of the start of the Queensbury Pot rift. This latter route emerges close to the southeastern end of Stream Chamber. Here it consists of a 1m wide, 10m high square-cut passage, formed by collapse on a massive scale. The floor consists of a jumble of very large collapse boulders of limestone, covered by a thick layer of sticky clay, except where this has been removed by water entering from a series of avens in the shattered roof overhead. The vadose trench which initially runs south-west past the foot of Stalagmite and Stalactite Chambers, swings abruptly through 90∞, heading north-west and enters this first section of Stream Chamber close to the north-east wall. To the left the pile of huge blocks may be climbed at several points to enter Stream Chamber itself. The trench appears to have developed as an escape route for the water entering this part of Stream Chamber via the holes in the roof, and flow marks in the trench indicate high velocity flow towards Sand Cavern.

Continuation of Stream Chamber is reached by climbing up the mud covered boulders from the end of the trench in a north-westerly direction on to a sticky mud floored plateau, on the south-west wall at this point a vertical slab of rock exhibits marked slickensides indicating horizontal faulting in a dextral sense. Ahead most of the passage floor is occupied by a 20m diameter, 20m deep vertical-walled pit, known as Mud Pot. This may be bypassed by a ledge of sticky, slippery clay, close to the left hand wall. It can be seen that the pit is largely developed in a thick layer of laminated sediments in which large, shattered blocks of limestone are buried. Solid rock is visible only against the north-east side. Immediately beyond Mud Pot the floor drops away steeply down a slippery mud slope for a total distance of 8m into the main and largest section of Stream Chamber, the floor of which is occupied by a small stream entering from a high level passage in the left wall. The middle of the chamber floor is occupied by an enormous block of rock, some 10m long, 2m wide and 4m high, which has fallen from the roof some 20m above.

The water from Stream Passage crosses the floor of Stream Chamber and after flowing underneath this large fallen block, disappears down through a choke of loose boulders against the north-east wall of the chamber. Beyond the stream, the main passage continues in a north-westerly direction, maintaining the same impressive dimensions. The floor is occupied by rising mounds of mud sloping down from each side to a narrow trench in the floor along which a small stream flows in wet weather. Stream Chamber continues for a further 200m in a north-westerly direction, past a pile of fallen blocks lying on this steadily rising mud floor, over much of this section a 2m diameter half tube is visible in the roof meandering from side to side, occasionally meandering out through the side of the passage and back in again in a series of out-of-step phreatic loops. Eventually the mud floor meets the roof with a series of muddy crawls through excavated tubes leading to a squeeze excavated through soft calcite. Beyond this point the passage continues for a further 50m over the floor of mud and boulders eventually reaching a 5m pitch via a tight crawl. At the base of the pitch, the small inlet stream, is again encountered and the passage may be followed for a further 50m until a large aven chamber is reached. The water forming the small stream-way enters the passage down the aven which has a scale to a height approaching 50m, before reaching the choke of unstable boulders. Beyond the aven the main passage continues a further 30m but rapidly diminishes in size and eventually chokes.

Stream Passage

The water entering Stream Chamber at its largest section in the vicinity of the large fallen block flows from a 2m wide, 7m high vadose side passage which opens in the south-west wall of Stream Chamber some 2-m above floor level, to run south-west for some 20m before abruptly swinging left. A 2m high, vertical wall of sand and cobble fill is visible on the outside of running the bend. The next 30m of passage approximately south-east, are developed along the line of

faulting. The course of the stream is to be found in a series of high avens developed along the line of the fault, which forms the last pitch of the Stream Passage Pot entrance to the Gaping Gill system. Immediately prior to the first inlet aven a smaller, older passage branches off to the right. This may be followed for a total distance of approximately 150m in a south-easterly direction. For the most part it consists of a circular or triangular phreatic tube, 1-2m in diameter, developed along a pair of closely spaced joints which trend 1470. A narrow vadose trench has subsequently been incised in the floor. This is now partially blocked in places by the remains of an extensive fill of sand and cobbles, which has only partially been cleared. The small stream enters from a bedding plane siphon at the foot of a 15m high blind aven at the south-eastern extremity.

Back in Stream Chamber the water may be followed to where it sinks amongst loose boulders beyond the large fallen block. A 3m climb down amongst boulders against the north wall at this point leads through to the bottom of Mud Pot. The upper PB is visible in section at the head of this climb. From the lowest point at Mud Pot a route through a large boulder ruckle descends for 15m and enters a stream passage in solid rock. The water sinking in the floor of Stream Chamber enters here. Stream Passage runs north, north-west and then north-east for some 20m before ending at the lip of a 15m wet pitch into a boulder chamber, developed along a joint or fault parallel to Stream Chamber and 50m below it. The stream leaves Boulder Chamber at its south-east end and soon sumps. Exploration beyond this point has revealed a further three short sections of passage with sumps between each section. The fourth and final sump, which is located directly below the pitch in the floor of Sand Cavern, was dived to a depth of 9m in a south-easterly direction, without discovering any further open passages. It is possible that the stream seen in King Street, at the bottom of Queensbury Pot, is in fact a continuation in a southeasterly direction of the water from Sump Four in Stream Passage.

South East Passage

From T-Junction, South East Passage runs southeast for approximately 20m as a low arched roof, phreatic tube between 1 and 1.5m high. The floor rises gently for a distance of about 1m and consists largely of a mixture of pebbles of both angular limestone fragments and rounded gritstone cobbles overlying a layer of mud and sand. Flow marks some 3 to 4 cm diameter on the roof indicate former slow flow to the southeast. A pair of small solution chambers is next encountered developed along joints trending 1470. From these chambers the passage swings due south for a further 30m passing en route yet another solution chamber developed along the line of the joint trending 1400. 10m beyond the latter a much larger solution chamber, South East Chamber, is entered. This is developed along or in a zone of very close jointing; the joint spacing varies between .5cm to 3cm and the joints themselves trend 147/1500. The chamber is some 3m wide and 7m long and high. It is clearly phreatic in origin with intense solution bucketing visible along the joints in the roof. Clear evidence of an extensive fill stage remains in the form of 30cm long water worn boulders wedged in solution tubes in the roof and the remains of stalagmite sedimented pebble and sand layers adhere to the walls high up on both sides of the chamber. Removal of the bulk of this fill has resulted in partial breakdown of the chamber walls particularly on the southwest side where large thin flakes of rock are in process of peeling away. Three passages leave the chamber, to the northeast, the southwest and to the southeast.

All but the latter passage choked to the roof with sand and gravel fill after a few metres. The latter passage itself runs gently down hill to the southeast and is smaller, lower and apparently younger than the passage entering South East Chamber. Not only is it lower and of smaller diameter, but the flow-marks are much smaller and more sharply incised on the low arched roof. After a total distance of approximately 50m, a T-Junction is reached. To the left the passage continues to a fork, the left branch of which rapidly becomes lower and encounters a pool. Eventually the roof meets the water in all but the driest of water conditions. This is Amphibian Passage, a tributary to the Hensler's Master Cave System. The right hand branch at the fork is of much smaller diameter and swings right until it abruptly enters the large chamber of South East Pot. Back at the T-junction a low bedding plane passage partially choked with sand can be

followed for some distance in a northwesterly direction heading towards Sand Cavern. Directly above this passage a 2m climb leads into a high level solution chamber whose walls show further evidence of faulting in the form of shattered rock flakes. To the northwest a low bedding plane quickly chokes, but to the southeast the chamber floor rises a further 2m over broken rock before opening abruptly as a high level window some 5m above the floor of South East Pot Chamber.

South East Pot

South East Pot is the name usually given to the large aven chamber entered by the two routes described above. It is some 10m wide by 15m long and is developed in the plane of a fault trending southeast. The floor of the chamber is largely occupied by the pot or shaft itself which descends a total distance of 40m through shattered rock before ending in a normally static pool of water, whose surface is the same level as the water in Terminal Lake in Ingleborough Cave. The pool has been plumbed to a depth of over 20m without finding any sign of a bottom, and underwater exploration by cave divers has failed to reveal any sign of major flooded passages leading off. However, dye tests have shown that the pool is on the main flow route between Main Chamber and Ingleborough Cave, and recently a decent made under flood conditions revealed the fact that the surface of the pool, far from being static, appeared to be a section of a high speed flow route with standing waves and muddy peat-stained flood water. The roof of South East Pot Chamber consists of a 10m diameter vertical shaft rising out of sight for a distance of 43m down which a small stream normally enters which is considerably augmented in wet weather. The shaft in fact forms the last pitch of the Flood Entrance Pot System, the first of the alternative entrances to the Gaping Gill System to be discovered.

A narrow ledge runs around the left hand, northeasterly, side of the chamber. The upper PB is clearly visible in section immediately above this ledge and the small rocky tube forming the alternative entrance to the chamber enters the middle of the chamber at ledge level and clearly is developed on the PB in the first instance, but subsequently trending through it. On the far side of the chamber a steep climb over mud-covered boulders rises some 5m to a continuation of the passage running southeast. This consists of a narrow phreatic passage running for some 20m with a flat mud-floor in which two holes lead vertically downwards through boulders back into South East Pot. The roof forms a pointed arch, 1.5 to 2m above the floor and solution pockets develop along the line of the vertical fissures in the rock. One solution pocket shows signs of post-solutional fault movement along the line through its centre. The movement appears to have been largely horizontal in a sinistral direction and its magnitude is of the order of 2cm. Large shallow floor marks on the walls of this section of passage indicate former slow flow under phreatic conditions in a northwesterly direction, i.e. towards South East Pot, and traces of the flow marking can be seen on the walls of South East Pot Chamber itself, some 5m above present floor level. After some 20m the passage enters another high aven chamber which forms the last pitch of the Bar Pot route in Gaping Gill. This portion of the system will be described in the section dealing with Bar Pot itself.

Hensler's Stream Passage System

Bounded on the north by the Old East Passage - Mud Hall - Far East Passage system and to the south by South East Passage - Bar Pot systems, the complex of passages known collectively as the Hensler's Passages, form a unique system, several kilometres in length. It consists of a set of six tributary passages all developed originally as small phreatic tubes immediately on top of or within the thickness of the upper PB, which converge on a junction located some 400m southeast of the Main Chamber. Downstream from the junction, Hensler's Stream Passage rapidly enlarges forming a major vadose stream passage which runs north-east then south-east for some 200m before ending in a sump, located some 10m below the PB. All but one of the tributary passages are unique in so far as they have developed as drainage channels from existing portions of the Gaping Gill system. The sixth tributary and the only one now active in all weather conditions, is fed by the high level vadose Disappointment Pot system. The six tributaries are described in clockwise order from south to north as follows: Disappointment Pot tributary, New Hensler's Crawl, Old Hensler's Crawl, Old East Tributary, Link Crawl and Mud Hensler's Crawl.

New Hensler's Crawl

New Hensler's Crawl commences as a narrow slot excavated through mud and boulders at the foot of the north-east wall of the second aven chamber in Far South East Passage, immediately to the south-east of the main Bar Pot entry aven (see Bar Pot System). The slot descends approximately 2m to enter a flat-out crawl with a solid rock roof and a mud and gravel floor. After 20m the floor lowers slightly and the passage can be seen to be approximately 1m wide. Walls on both side consist of the upper PB and numerous 1-5cm diameter phreatic tubes are visible in the walls developed on the upper surface of the PB. A low inlet on the right occasionally contains a small stream which is possibly that sinking in the floor of Far South East Passage. The crawl continues to head approximately north-east and enlarges slightly beyond the junction of an inlet from the left which is downstream end of the normally sumped Amphibian Passage, which links back to South East Passage, close to South East Pot. After a further 30m the crawl forks with the stream, if any, taking the right hand branch. This branch normally contains a pool of water which rises to within a few cm of the roof and is therefore normally impassable.

The left hand branch forms a low oxbow floored with very sticky clay which loops round some 30m before rejoining the stream route. Beyond this point the floor falls steadily and the sediments on the floor change from mud through gravel to small gritstone boulders in a sandy matrix. After a 100m the passage has attained a comparable walking height as a vadose trench develops in the floor. The original phreatic half tube remains visible above the trench with an arched roof above ledges on either side of the trench, which are largely occupied by remains of the sandy boulder fill. Over the last 30m the passage turns to head south-east along the line of a close-packed set of joints which trend 1250. Although the roof of the whole of this tributary has maintained essentially the same stratigraphic horizon, no sign of the PB can be found, either in the roof or the walls of the passage, and it appears likely that it has feathered out at some point along the crawl. (See description of same phenomenon in the Mud Hensler's Tributary.) A 1.5m high passage enters on the left at ledge level. The ledge itself has undergone a small degree of vadose trenching at this point and the close spacing of the joints (between 3-5cm) is clearly visible in the floor of the inlet over the last few metres. This inlet passage itself is the downstream bed of Old Hensler's Crawl, Old East Passage Tributary and Mud Hensler's Tributary combined. Beyond the inlet the main stream passage enlarges rapidly with deep pools in the floor developed along the joints. After a further 20m, a major passage enters from the left at Disappointment Junction but is the main stream, which enters via Disappointment Pot.

Downstream of Disappointment Junction, Hensler's Stream Passage, sometimes known as Hensler's Master Cave, enlarges its impressive dimensions up to 10m wide and 15m high. Beyond the junction it has swung left and runs for a further 100m in a north-easterly direction, cutting abruptly across the zone of dense jointing before swinging through a 900 to run south-east along the joints over the whole of this section of the main Stream Passage, the roof maintains its original flat bedding controlled level and sediment laden ledges continue to flank the major floor trench. Halfway along this section a fine set of 1cm diameter phreatic half tubes are visible in the roof as a complex meandering network.

Beyond this point a 2m diameter half tube closes the main passage running from north-west to south-east. To the left this may be followed through a sediment choked crawl which emerges in the Mud Hensler's Tributary. Prior to the abrupt swing to the south-east a small stream enters along the line of a joint close to the floor of the Main Stream Passage. It is presumed that this water also enters from Mud Hensler's Tributary where it sinks in a narrow choked floor slot. A large rock bridge is visible high in the roof of the Main Stream Passage at the bend. Beyond the bend the main passage continues a further 60m to a major junction. To the left the stream drops down in a series of small cascades into a deep pool under the left hand wall and enters a flat floored triangular cross-section passage which runs for a distance approaching 150m along a single joint, trending 140∞. The roof varies in height from 1-2m before finally meeting the water at a siphon pool. At several place near the commencement of this last section of passage, low arches in the right hand wall rise steeply up sand and boulder slopes to connect with the right hand branch. Approximately halfway along the active left hand branch, mixing corrosion along the line

of the joint has resulted in the upward development of a fine series of solution pockets in the vicinity of which an appreciable air current has been reported, although it has not proved possible to trace their sources. From the fork at the end of the main Stream Passage the right hand branch rises steeply to a level of some 10m above the active left hand branch up a slope of sand and boulders.

On the top of the slope the passage continues to run south-east over an approximate level floor of mud, sand and boulders, covered in places by extensive sheets of flowstone and stalagmite solutions. The passage is approximately triangular in cross-section running along major joints trending 1400. The roof varies in height from 1-3m and the walls are covered with deep, large flow-marks indicating the passage originated as a joint guided phreatic tube with slow steady water flow towards the south-east. Near the commencement of this passage several low arches on the left hand wall link via steep sand slopes to the active stream branch below and to one side. At one point along this initial section, collapse along the line of the joint in the roof reveals the existence of a very much older joint-controlled phreatic tube developed some 2-3m above the passage below and completely choked with sediment sealed in place by massive stalagmite flows. After 30m the passage narrows and solution along the joint leaves the roof above the level of the PB but no trace of this particular lithology is seen; instead aim thick bend of rock composed largely of brachiopod shells closely packed convex surface upward can be seen to have replaced the PB.

After 60m the passage executes a sharp double bend swinging through a 1400 to the left and then back to the original south-easterly direction along a parallel joint. 75m beyond the double bend the passage widens and the roof rises over a collapse along two parallel joints to reveal a 1m by 2m oval aperture in the flat roof. Access to this by means of a rigid rusty iron ladder marks the commencement of the Far Country Series of passages. Beyond the iron ladder the main passage continues at its former level for a further 20m before entering by parallel phreatic joint chambers developed en echelon towards the north-east. A dry sandy floor slopes steeply down from one chamber to the next. In the third and final chamber a 2m drop into a static siphon pool terminates this branch of Hensler's Passage. From the survey it appears that this final chamber and the siphon pool itself are developed along the same joint and beyond the terminal siphon over the active low level branch. This is particularly confirmed by the fact that the water level in the two pools appears to be the same to within the limits of accuracy of the survey but the connection has not been established positively either by direct underwater exploration or by water tracing techniques. Accurate information as to the absolute level of the surface of the water in these pools is not available, but it would appear that siphon pool represents portions of a perched phreas developed at the levels of some 10-1 5m below the PB or its shell bed equivalent in this part of the system.

Old Hensler's Crawl

Sometimes known as Hensler's Long Crawl, Old Hensler's Crawl was first discovered and explored by Eric Hensler while wandering about, solo, on May 16, 1937 during the Whitsun Winch Meet organised by the British Speleological Society. The crawl leads off Booth-Parsons Crawl some 20m to the north of the junction of the latter with South Passage I. The entrance consists of a low, wide slot in the right hand wall of the Booth-Parsons Passage which at this point is developed directly on the PB. The PB appears to have undergone a minor degree of deformation in this vicinity and Old Hensler's Crawl appears to have developed within the thickness of the PB, aided by what appears to be oblique fracturing of this particular bed, clearly seen in section as the crawl itself is entered. The passage commences with a 50cm descent after passing through a low, wide, letterbox and consists of a very wide, very low, meandering passage which trends approximately south-east for approximately 150m. Both floor and roof consist of porcellaneous limestone and are heavily flow marked indicating a south-easterly flow direction. For much of the way the passage is too low to allow one to turn over and in places it is possible to get one's boots stuck between floor and ceiling. Several pools of water occupy shallow hollows in the floor, particularly along the right hand side of the passage which suggests that the crawl has developed along the strike of the PB which dips at a very low angle to the south. There are signs of occasional flooding in the form of fragments of grass, leaves and stems,

adhering to small straw stalactites.

A number of small "side passages" appear to lead off both the right and left but all of these rapidly lower, preventing further progress and may well consist of minor meanders or oxbows. After 150m the crawl meets another passage at a T-junction. The passage to the left heads north towards Old East Passage. It has no recognised name but will be referred to here as Old East Tributary, and will be described in the next section. To the right Hensler's Crawl continues a further 100-1 50m slightly larger until eventually entering the Mud Hensler's Stream Passage as a low, wide letterbox at roof level. Somewhere along this latter section the PB feathers out since no sign of it can be found at the junction of Hensler's Crawl with Mud Hensler's Stream Passage, but the precise point at which it occurs and whether it has any effect on the height or width of Hensler's Crawl remains to be ascertained.

Old East Tributary

This runs almost due north for 100-120m from the T-junction mentioned in the previous section. It ends in a low, wide flooded bedding cave, possibly less than 20m to the south of and approximately 27m below the level of old East Passage in the vicinity of this second major cross-joint chamber. It appears to have developed as a low level drainage route developed on the upper PB at a time when considerable quantities of water were entering Old East Passage down the plane of the Main Chamber fault, in much the same way as Booth-Parsons Crawl drained the first cross-joint chamber in Old East Passage. The latter has remained active under heavy flood conditions since water appears to be able to enter it through the east boulder choke, but Old East Tributary Crawl now appears to be deserted, even under flood conditions. The first explorers had to break down a stalactite barrier in order to reach the far end, as well as excavate an almost complete choke of dry sand material midway along the passage (Ref Gemmell and Myers 1952, pp47&61).

Mud Hensler's Crawl

As mentioned in the description of Far East Passage a narrow slippery climb between mud covered boulders is entered from the lowest point of the floor close to the south wall at the start of Far East Passage, directly below the large inlet aven in the roof. The climb leads to an oblique fissure between the overhanging south wall and the mud and boulder fill of the Main Passage. The fissure descends steeply a further 5-7m in a westerly direction. At its foot, some 15m below floor level in Far East Passage an oval cross section, horizontal, phreatic tube leads off south. The tube is approximately 1m in diameter and a 50cm deep pool of water occupies this lower half. The bottom of the pool contains a thick layer of mud which is quickly stirred up by the passage of cavers until the pool itself turns to liquid mud, hence the name Mud Hensler's. The pool runs almost due south for some 50m with two tight bends with limited airspace near its start. A rise in the floor acts as a dam containing the pool and the passage beyond is dry. At this point the floor can be seen to be the top surface of the upper PB, and the passage continues as a low oval tube developed along a minor bedding plane approximately 50cm above the PB. Shortly after this point the passage begins to swing south-west and a small vadose trench develops in the floor which cuts into the PB.

After a further 20m the PB, now visible in section in the walls of the trench close to the roof level, suddenly thins and feathers out. 10m beyond this point the passage, now large enough to allow progress on hands and knees, abruptly enters at floor level a large aven chamber, known as Hensler's High Aven. The chamber measures some 3m wide by 5m long developed along a prominent joint, trending 142/ 3220. The walls rise almost vertically out of sight and a small inlet stream descends as a series of heavy drips around the perimeter. Immediately to the left of the point of entry the chamber narrows along the line of the joint and a series of large solution tubes can be reached up a mud slope. These lead through to a second larger aven, Parkinson's Aven, developed along the same joint some 5-10m to the southeast. Hensler's High Aven itself has been scaled to a height of over 45m, but no inlet passage of any size has been found. To the right of the point of entry into the aven chamber a very low wet crawl leading for a total distance of over 100m heads north-west, eventually connecting with Old East Tributary close to the final siphon pool. This passage has no recognised name and it is suggested it be called Link Crawl since it links Mud Hensler's with the Old East Tributary. It appears to have developed as a bypass to the latter.

The main route leaves Hensler's High Aven at floor level directly opposite the point of entry as a low narrow vadose trench developed in the floor of the same phreatic bedding tube as seen in the first section of Mud Hensler's. Both in the floor of the aven chamber and for the first few metres of the passage beyond, the trench is developed in a wide limestone which at first glance resembles the PB. However, closer examination reveals that unlike the PB limestone this particular bed is coarsely crystalline and is packed with brachiopod shells. A few metres beyond the aven the PB suddenly reappears in section in the walls varying in thickness from 5cm to 30cm. A network of small phreatic tubes approximately 1cm diameter can be seen developed upon this bed. Small phreatic tubes enter from both left and right. The latter being large enough for it having been followed back to the north-east where it was discovered that it formed an outflow drainage tube from Parkinson's Aven. The main passage rapidly develops into a fine vadose stream-way with a 2m deep, 1m wide, meandering trench with deep pools in the floor cut below a wider, flat roofed phreatic passage, developed along a bedding plane marking the horizon of the PB which again has feathered out. A low oval window in the right hand wall developed along this bedding plane, marks the lower end of Old Hensler's Crawl. Immediately beyond this point the 10cm wide, 2-3m deep slot develops in the floor down which the stream drops. After 2m the slot turns left and disappears under the left wall, the stream having taken a short cut to the south-east directly into Hensler's Main Stream Passage.

Disappointment Pot Inlet

A small hole through large joint in the floor of the large chamber at the end of the Disappointment Pot system descends some 8 m -10m before entering a low, wide crawl heading northwest. After some 5 metres or so the floor which consists of sand and pebbles begins to fall beyond the point of entry of a small stream, entering from under the left hand wall. This is the Disappointment Pot water which has followed a slightly different route through the boulders in the floor of the last chamber of the system. The passage rapidly enlarges as the stream sinks down through the floor sediments and it can be seen that the passage originated as a low, wide, arched phreatic tube, developed upon the upper surface of the upper PB, which may be seen in section in the left hand wall, pierced by a number of 1-5cm diameter dendritic solution tubes. The passage continues for a further 60-70m increasing in size and eventually meets Henslers Main Stream Passage at a junction where the passage entering from the left leads to all the other tributaries to the Main Stream Passage. Under normal weather conditions little, if any, water enters from this left hand branch. The stream in Henslers Main Stream Passage itself largely consists of the Disappointment Pot Stream. It is clear from the way in which the stream rapidly enlarges in size below the Disappointment Pot Inlet that this stream is largely responsible for the vadose development of Henslers Stream Passage. Although the PB is visible in the walls of the Disappointment Pot Inlet, close to its start, it appears to thin rapidly in a northernly direction and the last remaining trace may be seen in the roof of the Disappointment Pot Inlet, 10-20m before the junction, as a thin, white sheet, less than 1.5cm thick covering a portion of the roof of the passage.

(In 2010-11 E E Whitaker, P B Warren and J Allonby discovered a further low passage "Near Country" extending some 200m between South East Passage and Hensler's Passage all of which appears to be on the PB level)