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WATERWHEEL SWALLET CHARTERHOUSE-ON-MENDIP

by

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ABSTRACT

A wide range of techniques was used to open up this small cave, 240 m long and 56 m deep, in the course of a dig lasting 9 years. Two sumps were removed, but the main obstacles to progress were massive deposits of mud tailings generated by Roman to 19th century lead working in the Blackmoor valley. The Mendip Hills Mining Company set up a waterwheel in the entrance rift and, when the wheel became redundant, disposed of mud tailings into the swallet. Mudflows of mobilized tailings surged down the cave during this period.

INTRODUCTION

The great rainstorm of July 10 1968 (Hanwell and Newson, 1970) caused catastrophic flooding in the Blackmoor valley at Charterhouse. The entrances to three small underground systems were washed open. One, under the west bank of the valley south of the Nature Reserve car park, was explored by members of the Mendip Caving Group for 10 m to a choke. They named it Middle Flood Swallet. A year or two later the entrance became blocked by fallen earth.

The dig that opened the cave as presently known began in June 1977 at the invitation of Somerset County Council, who own the land. Rather than work through the flood entrance, which was an artificial tunnel in unconsolidated stony clay, an entrance was sought through a depression 3 m deep in the ground above. Old water channels led into the depression from 19th century reservoirs constructed by Cornish miners further up the valley (Stanton and Clarke, 1984, Fig. 14). Crumbling masonry low down in the depression indicated that it had been used by the miners, and Somerset County Council required that a proper study be made of any buried structures that might be present. This was an interesting challenge.

THE DISCOVERY—AN EXERCISE IN CAVE DIGGING TECHNIQUES

Archaeological excavation of the surface depression occupied the first 48 working days. Masonry walls enclosed a deep elongated cross-shaped void, backfilled with rocks and tailings, the function of which was mysterious until the remains of a waterwheel 6 m in diameter were uncovered at the bottom. They are described later in this paper.

Beneath the waterwheel pit the dig broke into the Middle Flood entrance tunnel (Fig. 1) through its terminal choke. The uncomfortable possibility that water from the wheel had run out into the valley, not down a swallet, was ruled out when the choke was sectioned. Bedded gravel deposits more than 2 m thick had washed in from the valley in 1968, the current having been strong enough to transport a reinforced concrete fence post 10 m underground along the level tunnel. The 'old men' who serviced the waterwheel pit through the artificial tunnel had built walls to support the loose roof of rocks set in red clay, and we nervously extended them.

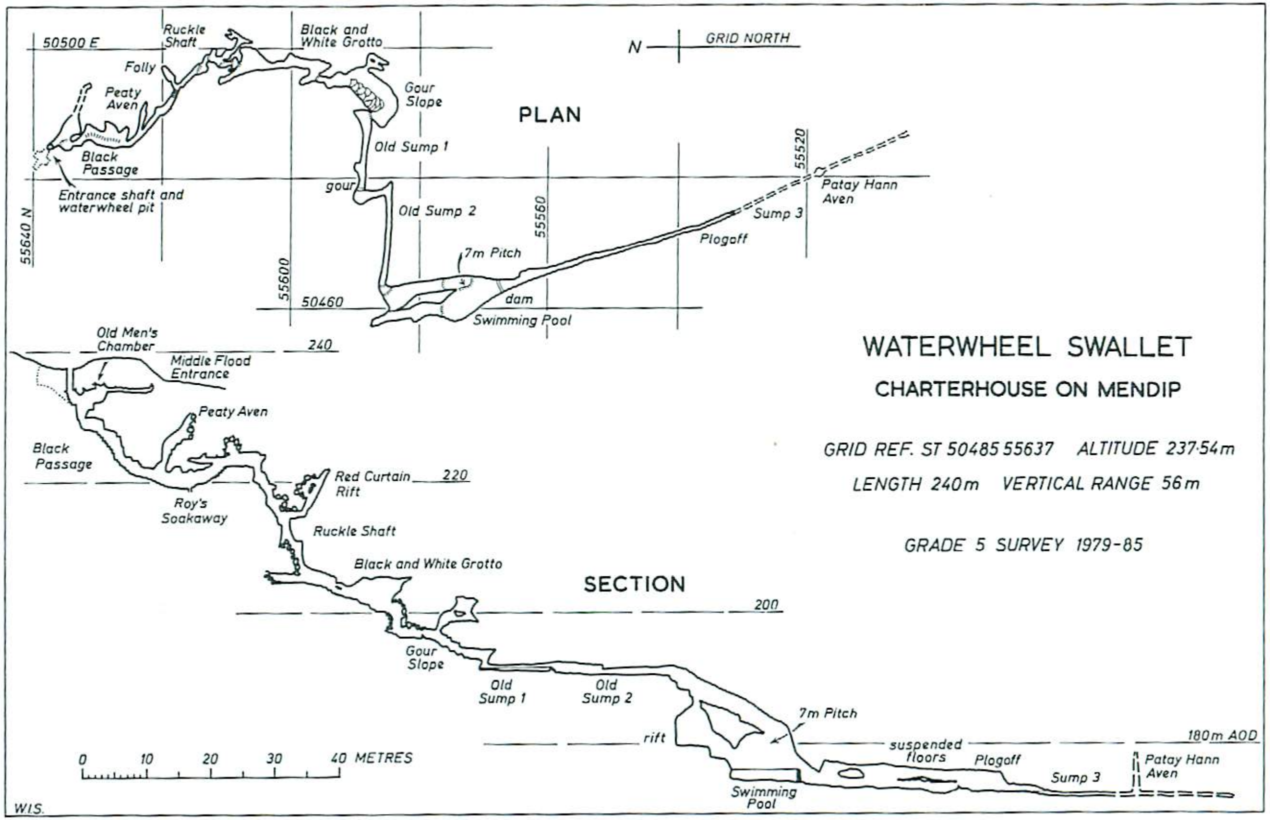

FIG. 1—SURVEY OF WATERWHEEL SWALLET

On the 64th working day a boulder ruckle beneath the choke in Old Men's Chamber was passed into a roomy passage that fell steeply for 20 m to a gravel choke. The walls and roof of this Black Passage were stained by black mineral films, against which a few white stalactites stood out in pleasant contrast (FIG. 2). The floor was of loose rock slabs at the angle of rest, and 11 days were spent in stabilizing it.

FIG. 2—BLACK AND WHITE STALACTITES IN BLACK PASSAGE
Phot.: N. R. Barrington

The gravel choke terminating Black Passage proved to be the start of a major obstacle. The 1968 gravel, containing turf, wood, tiles and 19th century slag, overlay grey-black laminated mud tailings in a massive deposit at least 3 m deep. At the upstream end the tailings passed into a flat-topped deltaic deposit of fine sand. Evidently they had accumulated in a wide deep pool. Advancing through the tailings became a nightmare when, after heavy rain, a stream flowed down Black Passage and flooded our walking-height trench. The floor had to be solidified with rocks and the sides supported by stone walls.

Above the tailings, to our surprise, was Peaty Aven, like a mineshaft 10 m high, liberally coated in its lower half with structureless grey mud tailings. In its upper half were brown soft flows and stalactites of peat-rust-calcite composition.

Beyond Peaty Aven the dig entered a rift less than 0.3 m wide. It was the only obvious way on, and as the walls had been battered by pebbles in the 1968 flood we followed it. The 1968 stream route emerged from the rift and ascended into a massive boulder ruckle piled against a solid rock wall, a buried cliff, on the right (south) side. We surmised, and later were proved correct, that the downward continuation of Black Passage was plugged with tailings and the 1968 stream had forced its way through the rift into the boulder ruckle of an adjacent depression.

Always following the battered stream route, and slowed by the need to stabilize the ruckle overhead, the dig progressed across the buried cliff face. Stabilization was achieved, as elsewhere in the cave, using cement mixed with 1968 gravel or sand from the delta. Another problem was flooding of the low point, the rift, by the Black Passage stream. Exploratory digging located an open crack in one wall (Roy's Soakaway) that could absorb a good flow. We dammed around Roy's Soakaway to keep out silt, but we had not bargained for the masses of charcoal grains washed from the tailings that swirled around in the water, neither floating nor sinking, and partly blocked the soakaway when they were carried into it.

All this time, debris was bucketed out to the waterwheel pit via the flight of steps that we built in Black Passage, or, when parties were smaller, to tips in Old Men's Chamber, Peaty Aven or Black Passage.

At last, on the 229th working day (October 1979), the battered stream route through the ruckle turned steeply downwards. Progress accelerated, helped by small boulder chambers against the cliff, but the ruckle still had to be cemented. The shaft was 17 m deep when, on the 271st day, a large passage was entered in the classic position at the bottom of the ruckle-filled sinkhole, 28 m below the floor of the Blackmoor valley.

The passage led down dip to a crawl beneath a forest of straws, to protect which the floor was lowered by one metre. A short way beyond was a boulder choke concealing a noisy stream. It was passed in 5 days' work. The stream was small, flowing down a staircase of black-stained gours occupying a wide low passage. At the foot of Gour Slope it entered a narrow slot between massive stalagmite flows and dropped half a metre into a sump pool.

Widening the slot was no problem. Then a dam was built upstream of the gours which retained the stream while four wetsuited bodies immersed themselves in the sump pool to displace water downstream. This successful experiment created a tiny airspace through the sump. Beyond, one gour was demolished and another bored through (FIG. 3) to turn the sump into a dry hands-and-knees crawl.

Round the next corner was Sump 2, approached over quivering banks of grey mud tailings. A dam was built of tailings and the sump bailed out into the large reservoir above the bored and bunged gour. The sump broke with a great 'clashing of cymbals'*. It had been 4 m long. The pile of rocks and tailings that had held back the water was at once removed.

Now a roomy passage sloped down to a 7 m pitch that was one wall of the largest chamber yet entered. The chamber floor could also be reached via a low-level rift and 3 m pitch. The little stream meandered across the chamber into a restricted passage floored variously with shingle and deep tailings. After 20 m a thin smooth rift, too tight at stream level, was passed by squeezing just below the roof. For 5 m there was a worrying risk of slipping down the taper and getting wedged. Beyond this awkward bit the rift widened slightly, the roof came down over deep tailings with a skim of gravel, and Sump 3 was reached. This was on the 309th day.

Sump 3 was rabbit-hole size, gravel over tailings. To pass it, we planned to use water power. Below the 7 m pitch a high masonry dam was built, with a hinged gate nearly 0.5 m square (FIG. 4) that could be opened to release a massive surge which, hopefully, would scour out the sump and remove the blockage at the far end. Concurrently, false floors of cemented rubble were laid high in the tapered rift to avoid the embarrassment of a rescue.

The first surge from the dam, when it was a metre high, released 45 m^3 of water. It backed up more than a metre at Sump 3 and the level fell slowly with a loud clashing of cymbals. An important blockage ahead must have been removed, because subsequent surges of up to 90 m^3 did not back up at the sump, though they did overflow the false floors, un-nerving the observer beyond. The noise, wind and violence of the surges as they bore down on the observer earned the name 'Hell of Plogoff' for the final rift.

As the dam approached 2 m in height the water pressure opened a succession of leaks through shingle and tailings beneath the cut-off trench. After 39 surges there was no perceptible change in water levels or other conditions at Sump 3, as was evidenced by the monotonous predictability (120 seconds duration) of the clashing cymbals. The diggers, fearing that the cave had them beat, began an outflanking manoeuvre.

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*At Wookey Hole Cave, Balch (1932, pp. 59-60) used the term 'clashing of cymbals' for historical reasons to describe the loud regular musical glugging sound made by air bubbling through from the Fourth Chamber to the Third, or vice versa, at the critical time when the sump connecting them was just opening or closing in response to changing water level.

According to the survey, Sump 3 was not far horizontally from the entrance of the so-called Grebe Swallet, but 57 m lower. In May 1981, on the 386th digging day, we sent the usual surge to Plogoff and then began re-opening the collapsed entrance to Grebe.

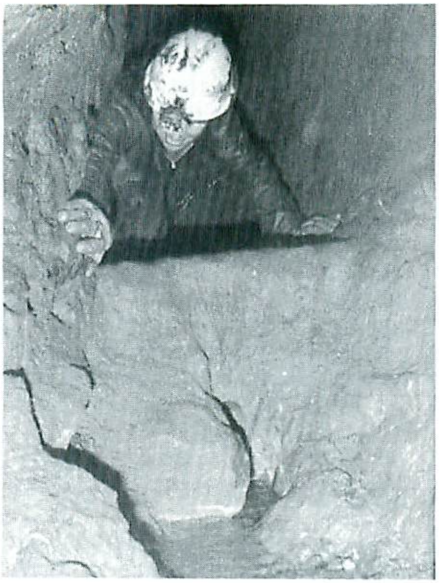


FIG. 3—THE BORED-THROUGH GOUR, LOOKING DOWNSTREAM
Phot.: G. Price

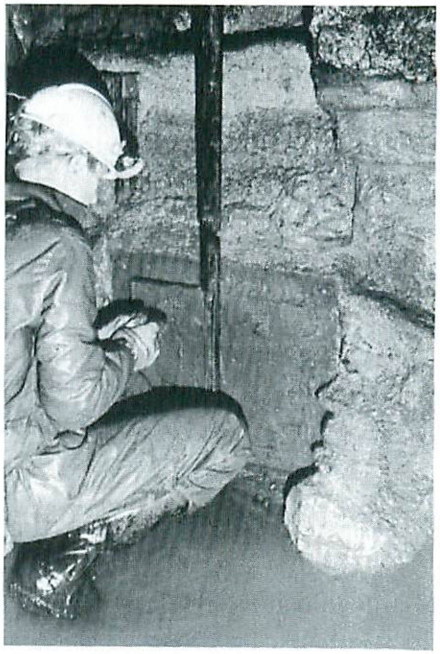


FIG. 4—SEALING THE GATE IN THE HIGH DAM WITH MUD
Phot.: G. Price

Four years later, Grebe Swallet Lead Mine showed no signs of being a bypass to Sump 3. The biggest and most violent Plogoff surges had been undetectable to silent candle-flame-watchers in the depths of the mine. It was time for the diggers to play their last card. They built a new dam of 20 m^3 capacity downstream of the high dam and, on the 422nd day, used a hand pump and hoses to pump the sumpwater into it. When the dam was full after three hours' pumping the sump level had dropped 0.35 m and the sump was penetrable, a body-sized tube, for only 6 m.

The diggers found another last card. They took 40 m of polythene layflat tube to Plogoff and surged it into Sump 3. When it was fully extended through the sump and beyond the downstream blockage they would pump out the sump through it. Easy! Unfortunately the tube kinked in the sump and after 5 days' struggle the idea was abandoned.

The final last card involved two hand pumps and 50 m of 60 mm diameter hose. The sumpwater was sent in two stages back to the high dam, now of 75 m^3 capacity. Seven hours' hard labour dried out the body-size tube for 15 m to Patay Hann Aven, named after the pumps and the body that they enabled to reach it. Fifteen metres further on the tube suddenly deformed to 1 m width and 0.1 m height, with a gravel floor, and sumped. At last the diggers really were beat. It was the 450th working day. They spent 23 more days in retreat, removing equipment, taping and tidying up. In February 1986 they returned the cave to Somerset County Council.

The most persistent diggers were Alan Clarke, Will Edwards, Bob Elliott, Pete Hann and the writer.

THE STREAMS

The upper or Black Passage stream enters the cave from the valley via the backfilled Middle Flood entrance tunnel. The fact that in flood time it becomes a torrent of up to 10 litres/sec. suggests that there is a culvert, built by the Mendip Hills Mining Company (MHMC) about 1860 to reduce flooding in the valley, beneath the tunnel floor. At such times the pool draining into Roy's Soakaway becomes a sump 5 m long. This stream only flows in wet weather.

Dye tracing proved that the upper stream, which vanishes into Roy's Soakaway and adjacent boulder ruckles, joins the lower stream. This is much less flashy and never ceased to flow in the period 1980–86, though it shrank to less than 0.1 litres/sec. in August 1980 when there was no flowing surface water in Blackmoor valley. In normal wet winter weather the lower stream seldom exceeds 1.5 litres/sec.

THE TAILINGS

Deposits of grey to black mud, that originated in the round buddles of MHMC (Stanton and Clarke, 1984), were massive and unpleasant obstacles as the cave was dug open. Rich in charcoal fragments and the shiny black root cases of a kind of coarse sedge that still grows abundantly in the valley, the muds are evidently the fine fraction of Roman to 18th century slags, slimes and other refuse dug from the valley floor and Town Field. They also contain bits of plank, fir bark, leather, peat, coal, coke and charred wood. Where the tailings settled out in pools they showed a thin subhorizontal lamination and included layers of silt and fine sand. Elsewhere, as on steep surfaces and between the boulders in ruckles, they were structureless.

At the height of MHMC activity the tailings accumulated to depths of at least 4 m in parts of the cave, as shown by remnant masses on wall ledges. There is evidence that these huge deposits sometimes became mobile and moved down the cave as mass flows of varying fluidity. Viscous flow is illustrated by a typical landslip sidewall scar in black mud, raised and striated, 3 m above the present floor near the foot of the 7 m pitch. Traces of very liquid mudflows occur from Gour Slope onwards as black films and blotches on the upstream sides of stalactites several metres above the present stream. The downstream sides are perfectly clean. Clearly the leading edges of some of the more mobile underground mudflows spattered liquid mud into the air high above them, as any fast-moving surface mudstream of the appropriate fluidity will do.

Smaller mudflows or slurries of liquified tailings trickled down through the boulder ruckles and were trapped in all the narrow gaps and angles. They had to be removed and replaced with cement when the ruckles were stabilized.

At several places in the cave the grey MHMC tailings overlay older black thinly laminated mud tailings that in some cases, as between Sumps 1 and 2 and from the 7 m pitch to Plogoff, had a reddish-brown surface crust, apparently a weathering feature. Between the pitch and Plogoff a layer of shingle separates the older and younger tailings. Whether the older tailings are Roman or mediaeval is not clear. As the weathering (MHMC tailings never show weathering underground) and the serpentine concretion bed (page 10) must have taken a long time to develop, a Roman age is suggested. In such case the absence of mediaeval tailings may perhaps be explained by blockage and burial of the cave entrances.

GEOLOGICAL FEATURES

The cave is developed in Black Rock limestones which are thin-bedded and fossiliferous, with shaly bedding planes and groups of thin shale beds at several levels. The beds dip southwards at 5° to 10°. Sumps 1 and 2 follow the east-west axial plane of a steep little monocline that downthrows to the south. The long straight final rift, from the 7 m pitch through Plogoff into Sump 3, follows an unmineralized master joint or small fault that trends SSE and is rather out of place among the mostly SE or ESE trending rakes and mineral veins of the Charterhouse orefield.

Vertical or steeply dipping neptunian dykes of reddish marly limestone, presumably Trias, trend NW past Roy's Soakaway and in Red Curtain Rift, and north-south below the Black and White Grotto. They are conglomeratic ('Dolomitic Conglomerate') locally, one dyke is interleaved with calcite veins formed by repeated gaping, and another shows internal lamination demonstrating that the marly sediment accumulated gradually, layer upon sloping layer, in the open fissure.

In the great ruckles filling the surface depressions, blocks of Carboniferous and Triassic limestones (with rare small sandstone boulders) are associated with a yellowish-brown stony clay that either encloses the blocks or fills the gaps between them. Entirely structureless, it is a massflow deposit that is gradually sludging down into voids as the opportunity arises. In most places the stones are residual chert and sandstone, locally with limestone. The gravel and sand component is also residual, including much edge-rounded Lower Limestone Shale material that decomposes to a sticky yellow clay.

From Old Men's Chamber to the foot of Ruckle Shaft the cave floor consists of boulders or gravel and mud, with no solid rock anywhere. One side of Ruckle Shaft is the 25 m high limestone cliff at the downstream end of an ancient swallet depression in Blackmoor valley, that is entirely full of sediment ranging from waterborne mud, sand and gravel through massflow stony clay to limestone boulder ruckles. Probably the depression is elongated, with its rock floor, close to the limestone/shale contact, rising gradually towards the outcrop of the contact c. 250 m upvalley. The several entrances to Blackmoor Flood Swallet (Stanton, 1976) may branch off from this depression. Long-lasting sediment chokes will have diverted the Blackmoor stream from one cave system to another, and back again, during development of the systems.

The gentle gradient of the cave floor from the 7 m pitch into Sump 3 is anomalous and must be caused, like the level floor of the pre-1968 Water Rift in Swildon's Hole (Kenney, 1968) by a build-up of sediment upstream of a blockage. Probably, therefore, Sump 3 follows the apex of the roof of a high rift passage.

A VARIETY OF SPELEOTHEMS

The cave is not particularly well decorated. At the foot of Black Passage some long stalactites were submerged, unbroken, in the MHMC tailings deposit. In Peaty Aven the brown stalactites (up to 0.3 m long) and stout stalagmites consisted of a variable mix of calcite, peaty organic matter and ochreous iron hydroxides, the last being cellular and sloppy, collapsing at a touch. The peat and iron in the Aven trickled down from above, the former as a particulate suspension from marshy areas of the valley floor, as at Blackmoor Flood Swallet (Stanton, 1976), and the latter as iron solutions leached from the mining wastes in the valley. Some vivid reddish ochreous wall staining has developed within three years of the wall being cleared of tailings.

At the head of Ruckle Shaft and in the Black and White Grotto flows of particulate peat from avens have mixed with calcite flows to create stalactites, curtains and bosses varying in colour from black through grey to white.

The gours of Gour Slope are of creamy somewhat tufaceous layered calcite except for the latest 2–5 mm which consist of brownish-black iron-peat-calcite mix. The change presumably follows the first mining disturbance of the valley floor in Early Iron Age or Roman times.

An unusual speleothem was present in the submerged mud tailings deposits of Sumps 1 and 2. About 0.4 m down in the grey muds was a single bed of very thinly laminated silt that became transformed, either by recrystallization or silica cementing, probably over c. 2000 years, into a discontinuous slab about 5 mm thick. Erosion of the tailings, both natural and during the dig, broke the slab into curved fragments which became known as the serpentine concretions (FIG. 5). They are entirely non-calcareous.

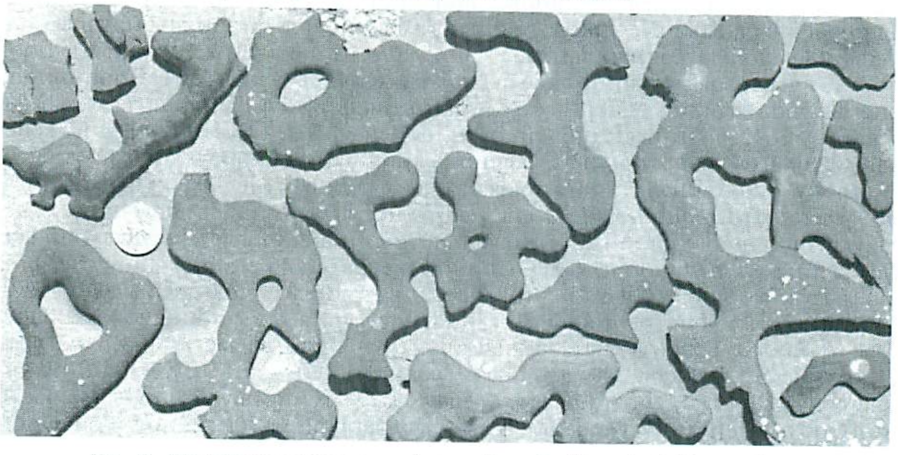


FIG. 5—'SERPENTINE CONCRETIONS' FROM SUMP 2. The coin is 28 mm diam.

NOISES

The 'clashing cymbals' of Plogoff, which signalled the point at which the slowly falling water level in Sump 3 allowed air to bubble into a flooded bell chamber, were one of a range of noises heard in the cave. All were the effects of changing water levels.

Below the 7 m pitch a hoarse roar, heard as the pent-up water rushed out through the high dam, was caused by air suddenly replacing water in a rising tube. If Roy's Soakaway is suddenly flooded, air displaced from interior voids appears from narrow cracks just below water level, bubbling, hissing and even seething 'like a great pot boiling' (Balch, 1932, p. 62) for several minutes.

Another noise was heard at the foot of Black Passage, quite loud, like a quarry siren, maintaining a single high note for 5 seconds before gradually sliding down the scale and fading away. This coincided with the return of the valley stream after the dry 1978 autumn. Presumably it marked the expulsion of air from a closed fissure by rising water. In the same place a year later a weak noise, between a gasp and a growl, was repeated at intervals of one second to several minutes for about half an hour, again as the cave was becoming wetter after rain.

MISCELLANEA

Various animal bones and teeth, flints, and Roman to Recent pottery, were found in the streamway and strewn along the 1968 flood route. Most, no doubt, were carried into the cave by the flood. In a branch passage to Gour Slope, well above any flood level, a few limb bones of a cat-like animal lay on the silty floor. Some were gnawed, and the complete skeleton of the possible culprit, a field vole (*Microtus agrestis*, identified by Mr A. P. Currant) was also present. These must have entered the cave alive.

Other effects of the 1968 flood were the transport underground of MHMC industrial rubbish including tiles, slag, wood, charcoal and furnace brick. Sand/pebble deposits under stalagmite floors were eroded and replaced by 1968 gravel. Grass was left hanging from passage and chamber roofs showing the minimum height reached by the flood waters.

The cave is 240 m long and 56 m deep. This includes the estimated 30 m underwater length of Sump 3. The survey, made using hand-held prismatic compass, Abney level and Fibron tape, shows that the furthest point reached is about half-way between the entrances of Grebe Swallet Lead Mine and Stainsby's Shaft (Stanton and Clarke, 1984, Fig. 14).

On abandoning the cave the diggers built removable bungs into the drained gour below Sump 1 and the high dam. When they are in place the old sump is a float-through duck and the passage to Plogoff is reached by swimming across a lake 1.5 m deep (FIG. 6). The intention was to provide Mendip with something it previously lacked, a short very wet cave trip.

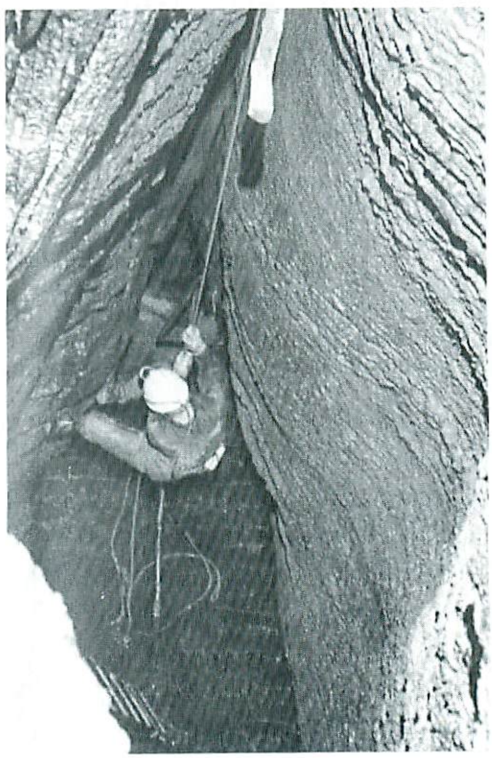
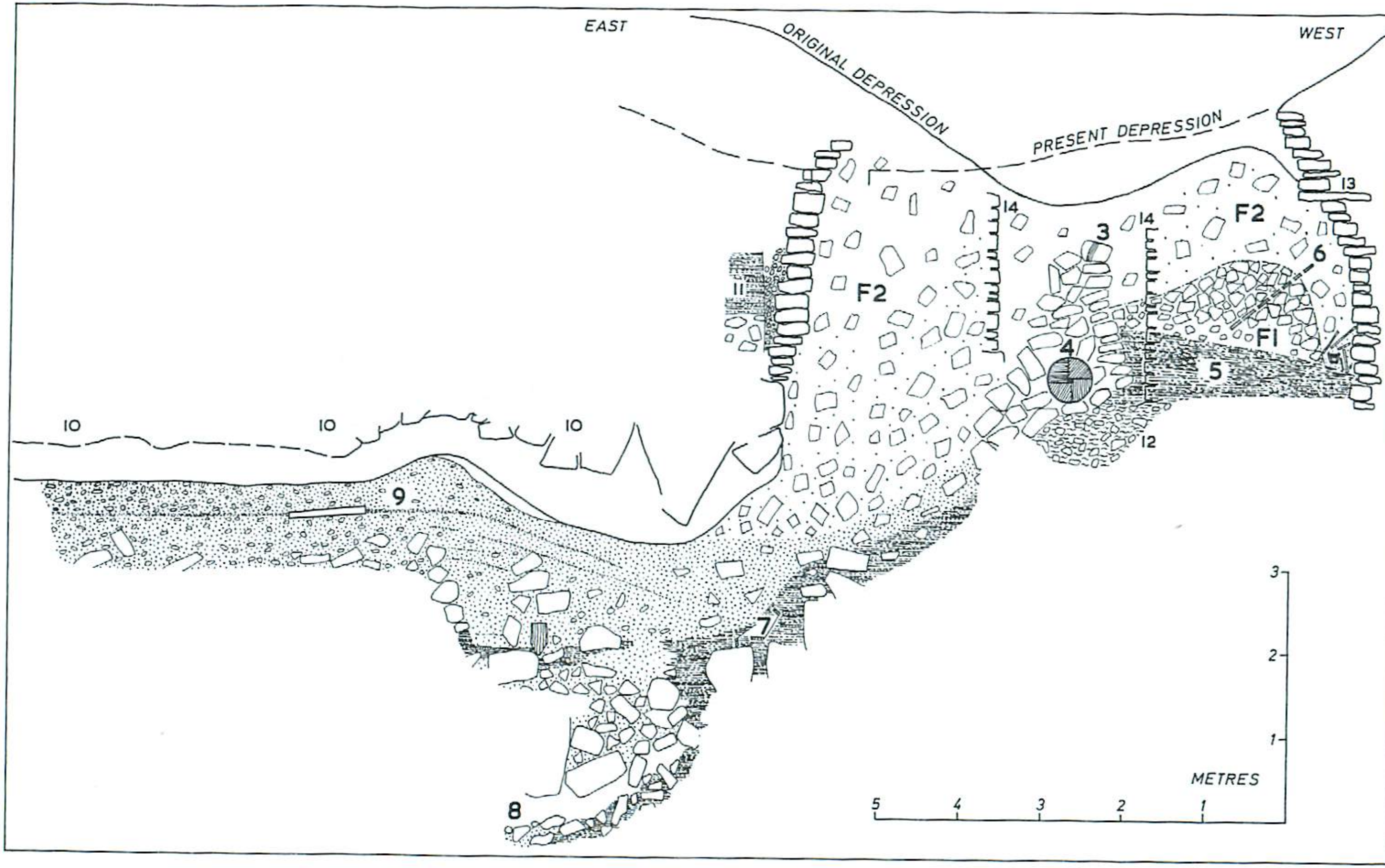


FIG. 6—CROSSING THE LAKE WITHOUT SWIMMING
Phot.: G. Price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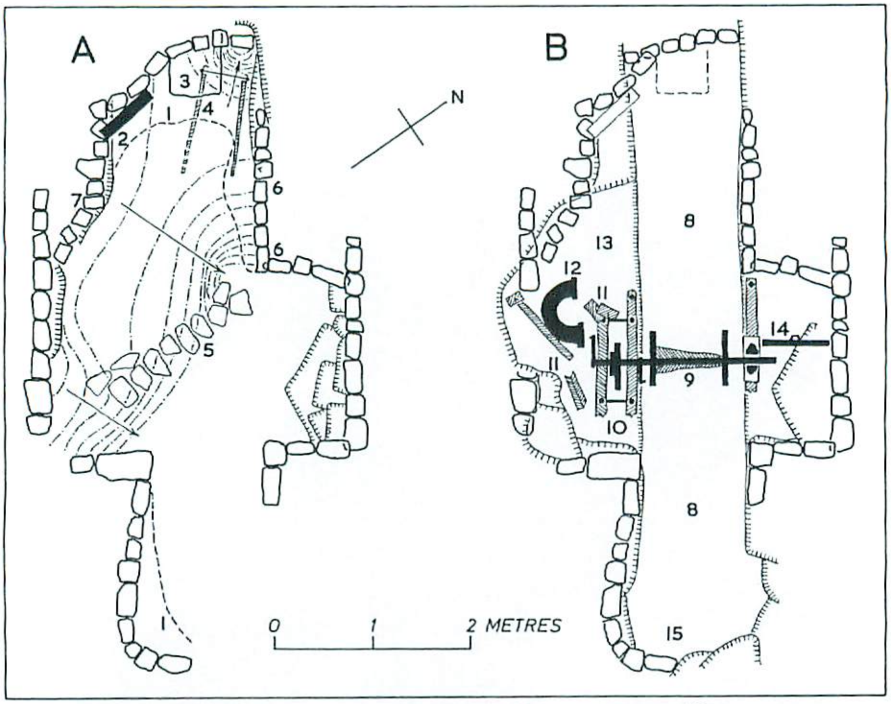

FIG. 8—SCHEMATIC PLANS OF THE WATERWHEEL PIT AT (A) UPPER LEVEL, (B) MIDDLE LEVEL. MASONRY IS DIAGRAMMATIC; HATCHED OUTLINES ARE SOLID ROCK OR LARGE BOULDERS; DOT-DASH LINES ARE CONTOURS AT 0.2 M INTERVALS ON TOP OF LOWER BACKFILL MASS (F1 ON FIG. 7), WITH ARROWS POINTING DOWNSLOPE
1: Original overhang of masonry. 2: Furnace bar built into wall. 3: Large cantilevered stone slab. 4: Spokes and part of rim of waterwheel. 5: Top of rough stone wall enclosing tailings pit. 6: Rock and masonry blackened by falling water. 7: Stone with rope grooves in wall. 8: Waterwheel slot. 9: Waterwheel axle. 10: Waterwheel gearbox. 11: Plank and launder pieces in tailings deposit. 12: 180° bend. 13: Tailings deposit covering rock floor. 14: Iron-bound planks. 15: Position of present entrance shaft to cave.

Access to the cave is controlled by the Warden of the Somerset County Council Outdoor Centre at Charterhouse crossroads. At the time of writing a trusted leader system, leader plus not more than four visitors, is in operation.

THE WATERWHEEL PIT

The plans and section (FIGS. 7, 8) were drawn up as the excavation of the pit progressed. The lower half of the pit was never excavated and the upper

FIG. 7—(OPPOSITE)—SECTION THROUGH WATERWHEEL PIT AND MIDDLE FLOOD ENTRANCE
F1: Backfill of mined rock, calcite and clay. F2: Backfill of soil, gravel, slag and fallen masonry. 3: Rock grooved by waterwheel at top of rough stone wall enclosing tailings pit. 4: Waterwheel axle. 5: Mud tailings on pit floor. 6: Waterwheel spokes and rim fragment. 7: Waterwheel buckets set in mud tailings. 8: Top end of Black Passage. 9: Stony sand and gravel, with turfy layers and a concrete post, washed in from valley. 10: Rocks set in red clay. 11: Edge of waterwheel pit cut in clay, rocks and pre-MHMC tailings, with small stones packing gaps behind dry masonry. 12: Stones, slag and mud tailings in waterwheel slot. 13: Iron furnace bar and cantilevered slab set in wall. 14: Masonry walls enclosing gearbox area, projected.

half was backfilled to prevent vandalism of the machinery, which was buried *in situ*. The 180° bend (probably part of a steam engine) now forms the base of the masonry wall in Peaty Aven, and the iron-bound planks and the rock grooved by the waterwheel may be examined in Old Men's Chamber.

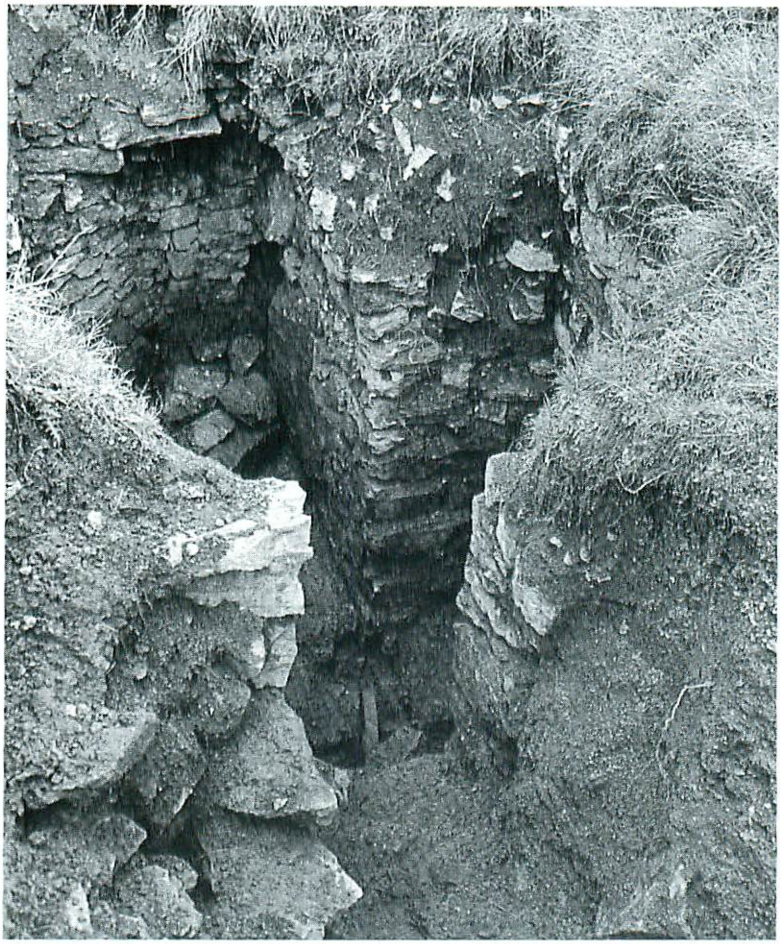

FIG. 9—THE WATERWHEEL SLOT PARTLY EXCAVATED, SEEN FROM THE EAST END
Phot.: N. R. Barrington

The waterwheel slot (FIG. 9) is a natural rift widened and shaped by shot-hole blasting. The first masonry construction above it was a wide, relatively shallow, possibly rectangular pit of which the masoned north and south walls remain at either end of the waterwheel axle. The cross-shaped pit was a later rather shaky construction of unmortared limestone blocks, some as much as 100 kg in weight. All the walls were founded on solid rock except at the east end where the foundation was boulders, which collapsed before the pit was finally infilled by MHMC.

Water was led to the wheel along channels from reservoirs much further up the valley (Stanton and Clarke, 1984, Fig. 14). The fact that one such channel (now levelled) continued beyond the pit suggests that the rift may have been revealed when the channel sprang a leak. Water flowed along a launder to the top of the (presumably overshot) wheel and leakage from the launder blackened the masonry beneath it, on the angle between the north and west arms of the pit.

The waterwheel was abandoned for a variety of reasons, including breakage of a gearwheel and growing instability of the rift and masonry walls. Some time after abandonment the wheel, which had wooden spokes and rim with buckets of wood and sheet iron (FIG. 10), was partly burned. The massive wooden hub, with iron wedges to control the set of the wheel, is largely consumed and charred. The western half of the pit was then isolated from the remainder by rocks piled into a rough openwork wall founded in part on the gearbox. Muddy silty water from buddles was led into this pit along a small launder of elm planks, V-shaped with a flat base, 150 mm high and 120 mm wide at the top. It filtered through the piled rocks and conveniently vanished down the swallet. Old Men's Chamber sometimes filled with muddy water when its boulder floor became clogged, and the Middle Flood entrance tunnel was used, perhaps even driven, to enable such blockages to be cleared. Then as now, cheap and easy disposal of tailings was vital to the profitability of mineral dressing operations.

Laminated grey and black mud tailings built up below the waterwheel and in the boulder floor of Old Men's Chamber, burying and preserving sundry planks, iron objects, waterwheel buckets, bits of leather and old boots. Finally, tailings accumulated to a depth of one metre on the rock platform beside the gearbox, dried out, cracked, and stood undisturbed for long enough for grit to fill the cracks, plants to grow on the surface, and a degree of oxidation, forming a surface skin of red mud, to occur.

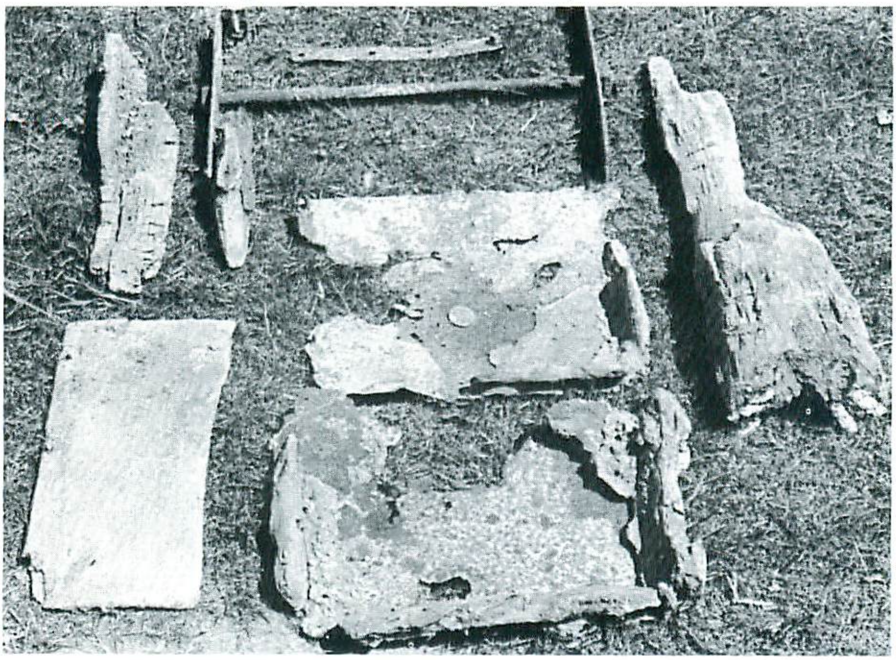

FIG. 10—OBJECTS FROM THE WATERWHEEL PIT
Clockwise from top left: part of elm launder; iron bolt and brackets linking spokes to rim; part of wooden axle hub with iron wedges whitened; two sheet-iron buckets; deal plank. The coin is 28 mm diam.

After the pit had been left in this state for a period, perhaps a year or two, cartloads of freshly mined limestone (with small stalagmites), vein calcite and red clay were dumped into the pit from its south side (F1 in FIG. 7). Parts of the wrecked waterwheel were still present and a spoke and rim fragment stuck out of the west side of the dumped heap. Beside it, planks, nails and lengths of launder choked with grey tailings rolled to the foot of the slope. The final infilling, F2 in FIG. 7, consisted of the dark charcoal-rich soil, sand, gravel and slag that forms the surface layers around the pit. It subsided into the pit, together with much masonry and rubble, as the arches and walls above the waterwheel collapsed or were pushed down.

What did the waterwheel drive? It is unlikely that MHMC would have bothered to transmit the power from such a small and seasonal source any distance, so the powered process was probably located beside the pit. When vandals damaged the overhanging masonry at the west end a flat layer of slag, overlain by a flat layer of roof tiles and much lime mortar, was revealed. They seem to be the remains of a shed with slag floor and masonry walls that were cannibalized for stone when the structure became redundant. If so, the process that went on in the shed left no lasting traces in the pit. A clue exists in the *Mining Journal* (Vol. 19, p. 249, May 1849) which sets out a proposal by MHMC 'to erect a workshop and sawpit in the valley' to serve the Blackmoor and Ubley operations. The waterwheel, which would seldom have been used in summer when the Blackmoor stream was low or dry, could well have powered a sawmill that prepared a stock of timbers and planks at times when water was plentiful.

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APPENDIX

THE WATERWHEEL MACHINERY (FIGS. 11, 12, 13)

by

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The core of the waterwheel machinery, the axle, consisted of an iron shaft 80 mm square with a bearing surface near each end, resting in two cast iron bearing blocks. These blocks were set in a wooden frame that was through-bolted variously to the solid rock and to brick walls built to make a level base.

Hanging on the shaft were two iron hoops of 0.55 m diameter that had retained the wooden hub. Several metal wedges, used for tightening the fit of hub on shaft, were still present in the remains of the hub. The shaft was fitted at one end with a cast iron straight-cut gear wheel of about 48 teeth. The design of the wheel was crude and it was broken. It drove a pinion of about 16 teeth on a short shaft set in smaller bearing blocks. The ends of this shaft were fitted with cranks set at 90° to each other. On these cranks were two iron connecting rods 1.4 m long with ends divided to take wooden rods. The 90° spacing of the cranks indicates that the rods probably drove a revolving shaft which could not be stalled in the top or bottom dead-centre positions.

The main shaft bearing blocks were not fitted with upper bearing caps. The weight of the waterwheel was supported by lower brass shell bearings. Traces of wooden keeps remained on the tops of the bearings. The bearing surfaces of the power take-off would have been very vulnerable to wear caused by debris falling on to them. Presumably, therefore, the powered operations were not located immediately above the waterwheel.

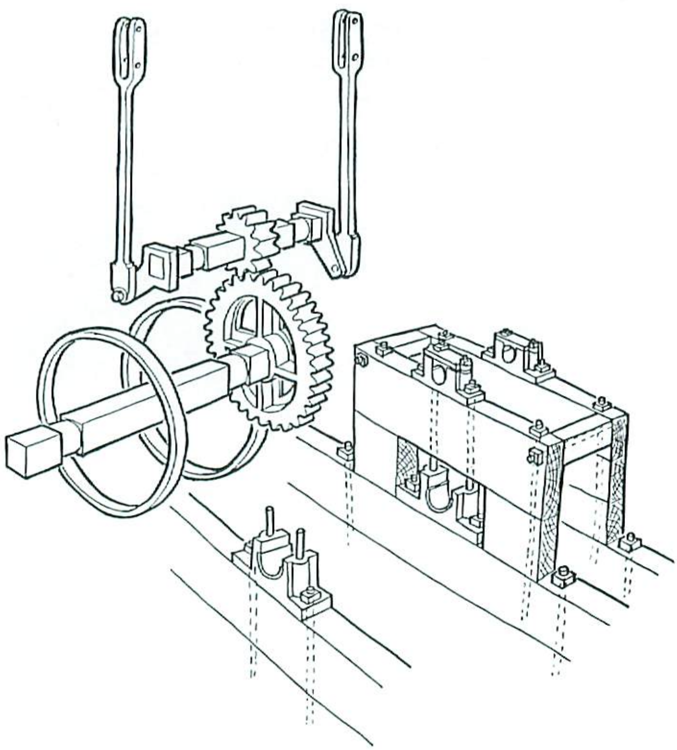

Fig. 11—The waterwheel axle and gearbox, not to exact scale. The moving parts are drawn displaced from their frame

FIG. 12—LOOKING DOWN INTO THE WATERWHEEL PIT FROM THE WEST END
The axle and gearbox are fully exposed and the cave entrance is below the figure
Phot.: N. R. Barrington

FIG. 13—THE AXLE AND GEARBOX PARTLY CLEARED OF MUD TAILINGS
Phot.: N. R. Barrington