The Big Hole of Starkholmes

John Jones

Abstract: A major ground collapse at Starkholmes, near Matlock, was caused by inappropriate site development over old mine workings.

East of the River Derwent, and almost above Matlock Bath railway station, the village of Starkholmes stands on a steep hillside of shale overlying Carboniferous Limestone that is penetrated by the Riber Mine.

Riber Mine

In 1950, when the price of lead was at a high, the Johannesburg Consolidated Investment Company came to Derbyshire in the general belief that major new ore deposits could be found where the "old man" (the miners of yesteryear) could not go due to the shortcomings of their equipment and the knowledge they had at their disposal in the 18th and 19th centuries. Matlock Bath was the chosen target site, and inclined exploration boreholes were drilled to intersect the rakes and veins lying on both sides of the River Derwent. All the drilling into veins to the west failed to find ore, as the "old man" had been there first.

But drilling in the east was more promising, where many veins are associated with the Great Rake along its length. Three inclined boreholes were drilled towards the south to intersect a rake length of 200 m, and all three were successful (Fig. 1). A major vein was encountered, at one place with 1.2 m of galena within a thicker calcite vein. The other two boreholes found sphalerite, also with galena values, and again in a calcite vein 2 m wide. The drilling programme seemed to indicate reserves of 60,000 tonnes of ore with a combined lead and zinc content of 8%, all lying below the level of the Derwent. This more than justified the cost of opening a new mine (Varvill, 1959; Greenough, 1967; Ford, 2002).

Underground work began early in 1952, and Riber Mine was born. An inclined drift, 3 m wide and 2.5 m high, was driven from below Starkholmes village, northeastwards towards Riber for a distance of 275 m. Starting at 149 m OD, this descended on a gradient of 1 in 3.5, to reach a level of 67 m on the vein (Fig. 2). It was then found that the 1.2 m rib of galena intersected by the drilling was only a pillar left by the "old man". If the borehole had deflected by a fraction of a degree either side, the Riber Mine would never have been developed. However, the Johannesburg Company carried on working the mine until April 1956, when Derbyshire Stone took over and worked the mine until closure in 1959.

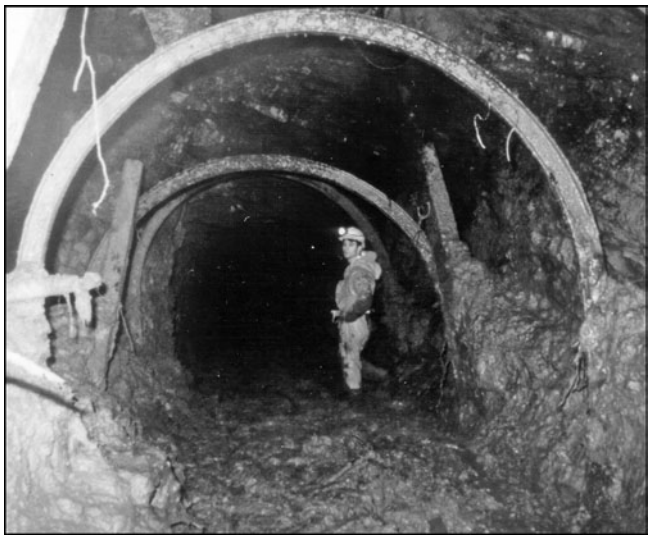

Figure 2. *The Riber Mine inclined drift, with steel arch roof supports at critical points (photo: Paul Barsby).*

In 1987 the land around the drift portal was sold to a building company for housing development, and one plot immediately above the inclined drift was given away free of charge as an extension to an existing

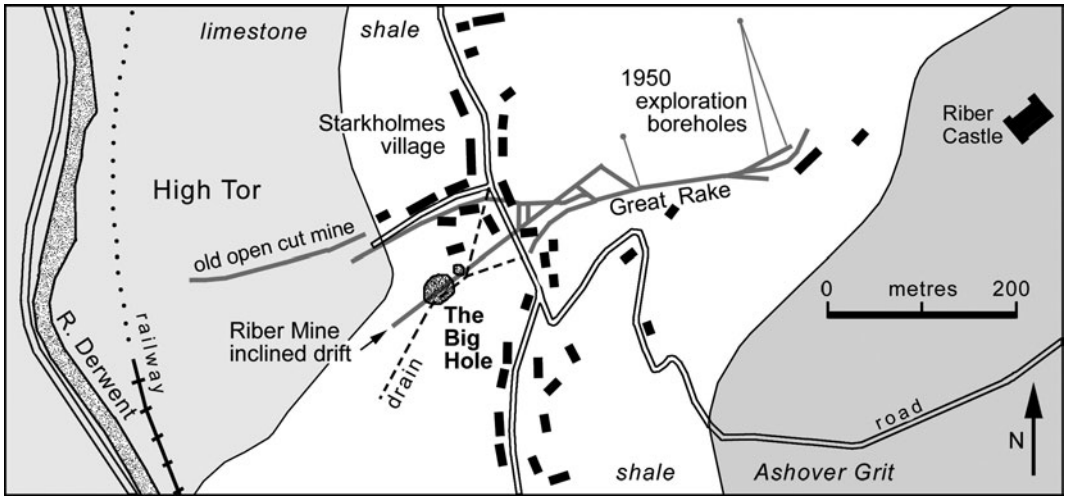

Figure 1. *Main features of the mines and geology around the Big Hole at Starkholmes.*

Figure 3. *The Big Hole on October 23rd.*

garden. Early in 1989, the new owner dumped quarry waste on to his garden extension, without planning permission and without knowledge of what lay below the ground. Later that year, and having been granted retrospective planning permission, he landscaped the site using 6000 tonnes of landfill. However, he had unknowingly crushed a clay drainpipe that extended beneath his plot, and crossed above the inclined drift. This culvert took stormwater from the road through the village, down towards the River Derwent.

Ground collapse

Some three years later, in 1992, it began raining in August, and continued almost unabated through September and into October. During the night of October 16, a hole appeared in the beautifully manicured lawn (Fig. 3). It was not very big, just an inverted conical shape about 10 m in diameter. But the rain kept falling, and by October 23 the new sinkhole had grown to 20 m diameter and 15 m deep. An open hole lay at the bottom, where the roof of the drift had collapsed under the additional load of the landfill when weakened by water from the now-inoperative culvert. The sides of the sinkhole continued to flare out by repeated slumping, as huge volumes of landfill fast

Figure 4. *The Big Hole when it had filled with water on November 10th (photo: Paul Barsby).*

Figure 5. *The Big Hole on November 11th, with the broken electric cable visible after the water had drained out.*

disappeared down into the mine. By November 10, the Big Hole had extended to an area 30 m by 20 m, and it was full of water (Fig. 4).

During the evening of November 11, the water all disappeared. At the same time, the lights went out in Starkholmes and Matlock Bath. It appears that the water had been held back by a temporary blockage within the inclined drift. When this had failed, the water rushed down in a giant whirlpool. And this had scoured the unstable sides of the sinkhole, with yet more slumping of the newly saturated landfill. The whole process carried away and broke an 11,000 volt electricity cable. However, the water had not travelled far down the incline. It was stopped by another choke, where tonnes of mud and debris were caught within the drift only a short distance down from the open sinkhole, but out of sight.

At 11 o'clock the following morning, a site meeting was called with representatives from Severn Trent Water, East Midlands Electricity, the local council, the county council, Tarmac (who had become the last owners of the mine by their takeover of Derbyshire Stone) and the Wirksworth Mines Research Group. All were gathered round the rim of the Big Hole, staring at the severed 11,000 volt cable that was hanging down its side (Fig. 5). All was peaceful, and it had even stopped raining.

Figure 6. *The second hole, on the collapsed mine shaft*

Suddenly, from behind and in the direction of the house, there was an enormous roar, and a fountain of water, soil and stones erupted 15 m high into the air. Muddy water and debris rained down on to the assembled party, and everyone ran for his life. A second hole had appeared in the sloping lawn. This one was only about 4 m across (Fig. 6), but it was a full 30 m deep. It lay northeast of the Big Hole, and was only a few metres from the landowner's house.

The water in the incline had penetrated and liquefied the mud that had been holding it, so that it could again pour down the inclined drift. This new debris flow of mud and water had then collided w four massive steel ring arches that were lining the drift.

Figure 8. *Setting off down the drift, from the foot of the Big Hole, to find the cause of the second ground collapse.*

These had been placed by the drift miners where they had intersected a shaft left behind by the earlier lead miners; just a metre in diameter, this shaft had since lain hidden above the ring arches. The same steel arches stopped the progress of the saturated debris flow and water down the drift; but this now had a partial escape route up the old shaft. The pressure of water, air and debris arriving at the blockage in the drift, blew upwards the loose fill within the old shaft.

It then blew out the top of the shaft that had been hidden under the lawn beside the house. What was a metre-square shaft down below expanded to a hole some 4 m across in the lawn. At first this new hole, and the shaft, were full of water, but this soon drained down, as mud, debris and water found their way onwards down the inclined drift.

Figure 7. *Multiple land slips progressively enlarge the Big Hole, until its rim approaches the driveway off to the left; the second collapsed hole is visible beyond the main hole and beside the large tree.*

Figure 9. *The first stage of the new shaft on top of the new access chamber into the drift (photo: Paul Barsby).*

A week later, the house owner's insurance company advised him to move all his furniture out if the hole came any closer - advice that was neither helpful nor innovative. But a temporary equilibrium appears to have been reached in the Big Hole, in its underlying drift and in the adjacent old shaft.

So work began on January 15, 1993, to build a concrete access chamber that enclosed the collapsed section of drift. This used 46 cubic metres of concrete, and was topped by an access shaft built upwards with concrete rings (Fig. 9). The shaft reached 12 m high as it was enclosed within the estimated 250 cubic metres of earth poured in to completely fill the crater. The project was completed on February 26 (Fig. 11), when the new access shaft was topped off with a steel lid. The second, smaller, sinkhole and its old mine shaft had also been backfilled.

The bad news was that the entire cost was carried by the house owner; the current mine owners could not be held responsible, as the collapse was essentially self-inflicted. A major ground failure had become almost inevitable when the landfill was dumped on the site and impeded sound drainage by collapsing the active culvert.

Figure 10. *Beginnings of the new shaft and the new drains within the Big Hole before backfilling (photo: Paul Barsby).*

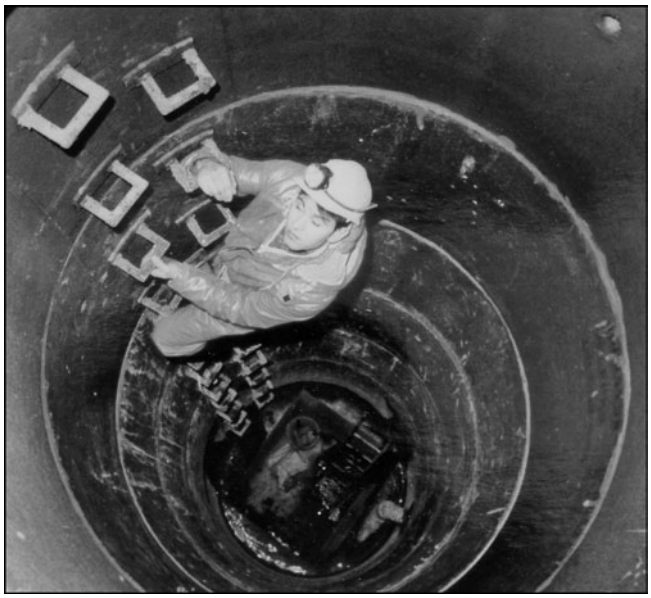

Figure 11. *Climbing the new shaft (photo: Paul Barsby).*

Acknowledgments

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John Jones
31 Bridgefields, Kegworth DE74 2FW

The old Allotment Shaft, lay almost directly above the Riber Mine, just east of the village road; it had originally reached down to the Coalpit Rake, a branch of the Great Rake, at a level above that of the Riber Mine's much later inclined drift. This shaft had also collapsed, in 1984, when the shaft fill had run in, leaving a surface crater 15 m across. The ground failed after the shaft had long been used as a toilet in the middle of the village allotments; fortunately, the allotments' 'facilities block' was unoccupied when the collapse occurred in the middle of the night.