Drilling Operations & The Sheppton Mine Rescue

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Underground mining has always had inherent dangers, with the most grave being the possibility of becoming entrapped or buried alive in a collapse. Historically, this has almost always been a death sentence for trapped miners. In some regards this was considered just another danger of the profession. Rescuers often couldn't reach trapped men before lack of food, water, or air had killed them, with many rescues turning into corpse recoveries. Even at that, many were not always successful (*Twin Shaft Disaster*, 2024). When three men were trapped at Sheppton, it was initially assumed at best to be a recovery operation.

However that's not to say there were never any successes - in 1891 Hazleton, five men survived an incredible 19 days before being rescued after the mine which they were in flooded unexpectedly (Webley, 2010). No food or water was present for these men except for their lunch pails, but after the first six days they resorted to drinking sulfur tainted mine water and consuming lamp oil. If these men did not have these resources with them during the accident it is likely they would have perished.

Other instances of trapped men surviving for unexpectedly long periods of time have also occurred in different situations. When the battleship USS West Virginia was sunk and eventually refloated after the Pearl Harbor attack, it was found that three men survived for 16 days following the attack before perishing from lack of oxygen. The storeroom in which they were in had rations for their consumption. They had marked off a calendar in pencil and the presence of a wristwatch among them works to give credibility to their survival (Haines, 2003). While the circumstance of these men being trapped differs from an underground mine, if men can be rescued in a timely manner and they are not injured in the event, there is a possibility of survival. In the instance of the Twin Shafts disaster, rescue progress was as slow as 20ft a day (*Twin Shaft Disaster*, 2024) and this highlights the difficulty in a timely rescue.

Prior to 1951, it was known that diamond drilling could be utilized to quickly drill a hole to a predetermined location where men were trapped with little disturbance to the bedrock. Through this hole, they could be supplied with food and water until rescue efforts reached them. In an instance recorded it is noted that when rescued the men were "in surprisingly good physical condition." (Ross, n.d.)(Cumming, 1951) This of course had proven that drilling could effectively be utilized to sustain men until rescue efforts have reached them.

In August of 1963, three men were trapped in an anthracite mine in Sheppton, Pennsylvania by a roof collapse over 300 feet below ground surface. Two of these men would eventually be rescued by drilling efforts in what became known as the Sheppton Mine disaster and rescue.

The Cave-In & Overview of the Situation

On August 13th, 1963 three men were working the Oneida No 2 vein of coal near Sheppton PA. These were employees of the Fellin Coal Company and were owner Dave Fellin, and employees Hank Throne, and Louis Bova. This was a small company operated by Dave Fellin and a partner where they were working at an older mine to remove any remaining coal. Their work for the day would consist of loading coal cars that would be sent to the surface. After the first few cars were loaded and being sent up the slope, the roof caved in and separated Fellin and Throne from Bova.

At first Fellin and Throne attempted to signal to the hoist operator that they were alive by tapping on the rails used for the coal cars, but discontinued this out of fear of being electrocuted by broken high voltage cables. These men then attempted to dig their way out by moving props and coal out of their way, but without tools they were unable to gain much progress. In the process, Throne was injured in the face by a piece of coal that struck him causing him to bleed and knocking some of his teeth out. Concurrently, they also attempted to contact Bova. Fellin and Throne expected rescue to come down from the slope but unbeknownst to them, rescue attempts through this method were prevented by mine gases and the risk of further cave-in, indicated by sounds due to the ground shifting. The plan to come down the slope would require backfilling the existing slope and driving a second slope down next to that. The time involved would turn the operation from a rescue to a recovery. (*Sheppton Mine Disaster, 50 Years Later*) (Sheppton.com, n.d.)

At the surface, Fellin's brother insisted that some test boreholes be drilled to confirm that the men were still alive, firm in his belief that the men's experience would guarantee their survival. Fellin's brother also had to contend with a legal battle during the first few days to get his idea for test borings to be approved (Sheppton.com, n.d.). In the mine, Fellin and Throne had resorted to drinking sulfur water but due to the taste resorted to wetting their lips with moisture from tree bark from the props which originally supported the roof. Throne's lunchbox was present, but was inaccessible due to the fallen props keeping it out of reach. (*Sheppton Mine Disaster, 50 Years Later*, 2013) At one point brief contact was made with Bova but was lost. (Waller, n.d.) Bova reported that he had a hip injury to the pair at this time. Due to the cold temperatures underground, the men kept warm by utilizing their body heat as best as they could to avoid hypothermia.

After five days, Fellin and Throne heard a voice they believed to be Bova from above their location, but turned out to be rescuers from the surface shouting down one of the holes. Afterwards a microphone was lowered down on a cable by local reporter Phil Margush. This fed into a tape recorder and acted as the only form of communication the men had with the surface. The men reported that Bova was about 15 feet away and related his known injuries. A phone line was attempted to be installed but this was unsuccessful. (Waller, n.d.) Through the borehole, food, water, and lights were lowered down to the men.

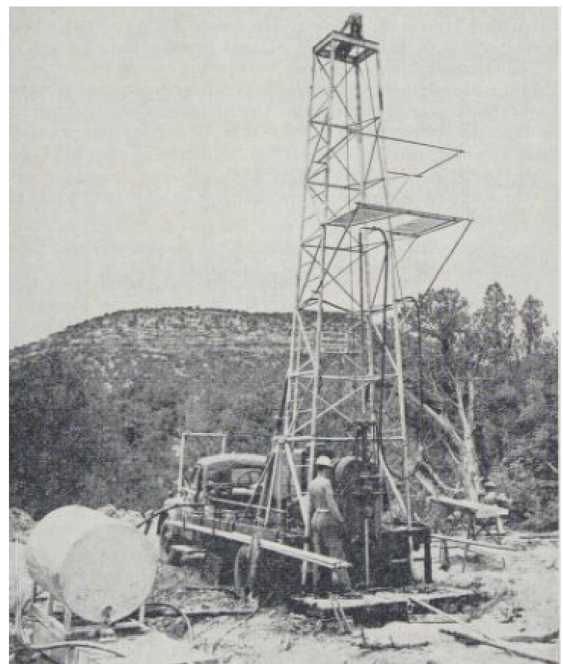
Due to the fact that conventional rescue methods could not be tried in a time efficient manner, it was decided that a borehole large enough for the men to fit through would be drilled. Through this they could be hoisted out. The 6” hole was used for lowering supplies and communication drilled by the diamond core drills would be maintained for this purpose. Also drilled was a 3” hole to attempt to contact Bova (Buckley, 1963). A large rotary drill was brought in to drill 12” holes, which would later be reamed out to about 18” to permit the men’s passage. On the first attempt a “sulfur ball” was hit that the rotary bit could not cut through. On the second attempt, the void the men were in was missed, on the third attempt, the bit broke through “only two or three feet away.” Through this larger hole, heating pads, a sleeping bag, and timbers were sent so the men could reinforce their chamber so the reaming operation wouldn’t cause further cave-in. The men were informed via the 6” hole when the reamer was right above them and after it broke through, harnesses, coveralls, and grease were sent down. The men greased each other up to reduce friction during the hoisting operation. Two weeks after the cave in, Fellin and Throne were saved. Unfortunately, Bova was not recovered and at the site is his tombstone, (Waller, n.d.) (*Sheppton Mine Disaster, 50 Years Later*, 2013) (Sheppton.com, n.d.). The mine would be his final resting place and he left behind a wife and son. Throne went on to give several interviews about his experiences and actually went back to work in mines afterwards, while Fellin largely stayed out of the public eye (*Sheppton Mine Disaster, 50 Years Later*, 2013).

The story of this disaster and subsequent rescue had laid the blueprint for deep mine rescues in the future, because now it was proven that rotary drilling was a viable method for rescuing trapped men and in later years would be utilized worldwide such as the rescue in Chile in 2010, saving dozens of lives, and giving miners confidence that if they are trapped, they can be rescued. (Corrigan & Tobar, 2014)

Drilling Equipment & Firms

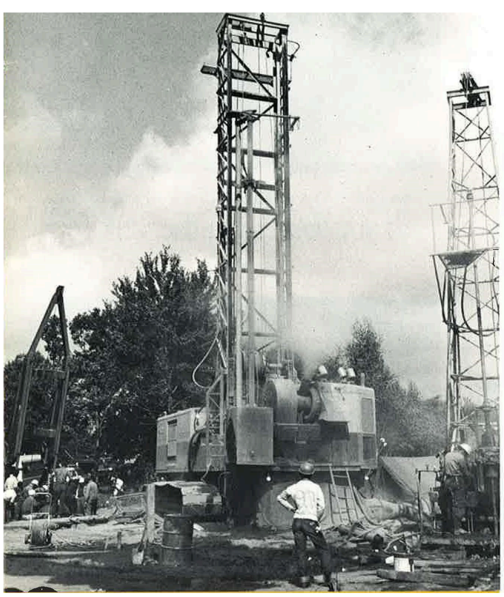
Because of the expansive anthracite mining industry in Pennsylvania at the time, there was no shortage of drilling equipment to be utilized. Many contract drilling firms had their headquarters in the Scranton area including two manufacturers as well, and many surface mines often had their own blasthole drills in inventory, while underground operations had smaller drills to utilize. In more conventional circumstances, diamond core drills would be utilized for exploration, and blasthole drills for production and processing of coal.

The diamond drilling firm of Sprague & Henwood had much experience in drilling for minerals and ores worldwide. At the time they were actually the largest drilling firm in the world. Their main office and factory was located in Scranton. It was known to company president Adrian Ross prior to the events at Sheppton that boreholes could be used for feeding trapped men until they could be rescued, so naturally Sprague & Henwood would be in a strong position to support the rescue operations. Few records survive of Sprague & Henwood's involvement, but because of the media presence many photos survive. It is known that they had a truck mounted model 142-C drill with hydraulic box derrick for drilling the 6” holes. (Underground Miners, n.d.) (Ross, n.d.)



Sprague & Henwood, Inc.

Fig. 112 Truck Mounted Drill with Hydraulically Operated Folding Derrick—Colorado Uranium Fields.



For the “rescue” drill, local mine operator Pagnotti Enterprises provided a Bucyrus Erie 50-R blasthole rotary drill. This was a 56-ton drill with electric motors powered by a diesel generator. It utilized 9” diameter drill rods over 30ft long each with rack and pinion hoists/pulldown systems. Originally it was intended for drilling holes 9“ to 12” in diameter at depths of 100ft for surface mining. Inside the frame a large air compressor was installed that would blow cuttings out from the hole (Lang, 2010). Billionaire Howard Hughes would provide the means for the hole to be reamed out to full size. However this required a reamer to be positioned behind it which was produced by Bear Ridge Machine & Fabrication. (Schreppel, 1998) (Anderson, 2016)

Various other auxiliary equipment were available on site as well, such as generators, welding machines, air compressors, and most notably a large crane that was utilized for handling the casing required to prevent the rescue borehole from collapsing. (Underground Miners, n.d.) (Albany.edu, 2000)

Unusual Challenges On-Site

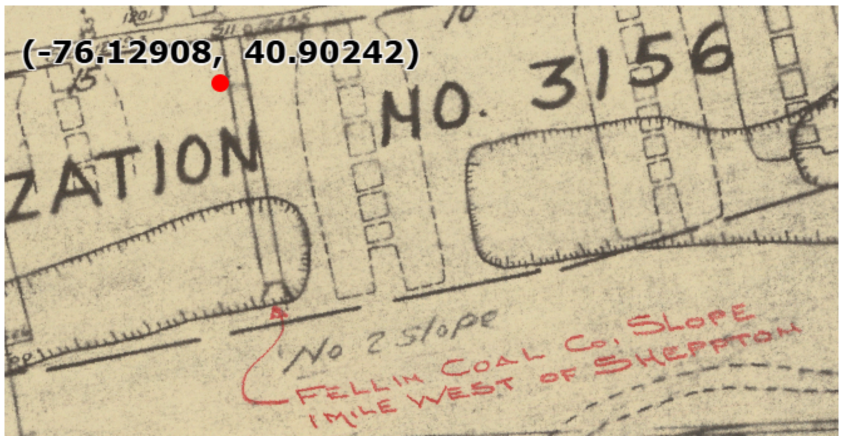
Compared to drilling conventional boreholes as would be done in blasting or exploration, the boreholes were complicated by the fact that the men might still be alive below the surface. This would not be an issue for the rotary drill, as it was equipped with compressed air. However core drills typically used water and photos suggest that compressed air was used instead (Underground Miners, n.d.). If water were used, it could risk flooding the void. Another complication was loose soil present on top of bedrock. This would have to be cased off to prevent soil from caving in. Photographs show 18” casing being lowered into the rescue borehole with a crane (Albany.edu, 2000). Mining blasthole drills are also typically only equipped with a rotary head or rotary table for turning the bit. Casing would have to be installed with the crane on site, requiring the drill to be pulled off the hole for installation. Afterwards, the drill would set back up, and continue the borehole to final depth.

Smaller diameter casing from the core drills are also still present at the site to this day (Serfass, 2023). These drills typically install and remove their own casing. Due to time constraints, it seems likely that this casing was left in the ground after each borehole. In other circumstances it would be removed and reused. The use of compressed air also had the advantage that water pumps and the necessary hose would not need to be laid out. With the traffic to and from the site from onlookers, these hoses would likely be kinked.

Crews worked around the clock and several rescuers succumbed to exhaustion as well. Due to the specialist nature of some of the rescuers, breaks could be few and far between (Waller, n.d.). Men experienced in maintenance of equipment stayed on site, in case they were needed (Schreppel, 1998). The Salvation Army and Red Cross provided meals for crews who remained on site (Jackson, 2023). Onlookers and media grew to be such a nuance, scaffolding was set up specifically for them.

Maps & Records

Some geologic records still exist, however much of the existing information is generalized. No surfical geology maps are available at present. It is known that some amount of overburden was overlying the bedrock because casing was required while drilling (Albany.edu, 2000). No specific drill logs or boring records are available. However, bedrock geology maps for all of Pennsylvania have been published, and so have mine maps (*Mine Map Atlas*, n.d.). It has been said that where the grave for Louis Bova is placed is the location of the rescue borehole, which helps place the exact site (GPS 40.90242, -76.12908).



Mine maps have always been criticized for their accuracy, and this is typically undeserved due to the effort and care taken by the surveying crew who could create maps to a surprising degree of accuracy (Emershaw, 2026). In any case it should be remembered that the cave-in occurred on one of the slopes leading to the surface. A survey station is shown at the bottom of the slope on Map ID BMSA_2022 (*Mine Map Atlas*, n.d.). The elevation listed for this survey station is 1249.5ft, with current surface elevation being 1592ft at the grave marker. Given that the slope proceeded north at approximately 350 degrees and recent mine maps were available at the time, rescue efforts started with some fairly up to date reliable positioning information compared to previous years. As it was unknown where exactly the men were, there was still guesswork and estimation involved, but a general idea of where to drill was known.

These maps also expose some potentially concerning information known prior. Map ID BMSA_2520-002 was updated frequently between 1952 and the disaster date. On that map, an area 250ft to the southwest of the slope is labeled as “poor top” indicating some concerns about the roof stability. Even more concerningly, an area 325ft to the east is circled and labeled “recent cave” (*Mine Map Atlas*, n.d.). It is unknown if the miners were concerned with these areas, but they were likely aware of them. The maps also indicate that pillars were robbed in the area with poor top, and the crew was allowed to remove pillars, working from the back of the mine towards the entrance (Jackson, 2013).

Geology & Drillability

Bedrock geology in Pennsylvania has been mapped in depth by the Department of Geological Survey. At the location of the disaster, the miners were working anthracite coal in the Llewellyn formation, which ran east to west at their location. Typical strata found in this formation would be anthracite coal, sandstone, siltstone, shale, and conglomerate (Pennsylvania Department of Environmental Protection, 2024). Typically formations are found in repeating sequences. Fossils are common, mostly being found in coal, siltstone, and shale, but can on occasion be found in sandstone. Generally the Llewellyn formation can be described as fairly typical for eastern Pennsylvanian geology.

Drillability in the Llewellyn formation isn't abnormal by Pennsylvanian standards. In diamond drilling, sample recovery in coal can be tricky at times, even requiring the invention of new core barrels for reliable recovery (Ross, n.d.). Sandstone drills fairly easy with diamond drill, as do shale and siltstone with proper bit selection. Most troublesome can be poorly cemented conglomerate, which tends to break up while being drilled. Also troublesome is iron pyrite embedded in coal seams, as this is significantly harder than the surrounding coal and can slow drilling progress significantly (Ross, n.d.). Often issues with lost circulation occur while drilling using water and it is not uncommon for several strings of flush joint casing to be used on deeper holes (Cumming, 1951). Due to the close proximity of the Pennsylvania diamond drilling firms, at this point many had decades of experience in this type of geology.

For drilling where no samples are required, rotary is a well suited method. Shales and siltstones tend to be friable and break apart easily, as does the coal. Sandstones and conglomerates put up more resistance to being cut with a rotary bit, but progress can still be maintained at a steady pace. Iron pyrite evidently gave issues with drilling the initial rescue borehole, with the hole having to be offset and attempted again (Waller). Generally carbide roller bits are most ideal for this formation to deal with sandstone and iron pyrite pockets, but steel tooth bits have been used with success. Some photos indicate that a steel tooth bit was used (Dino, 2010).

Drilling the Initial Boreholes

Much of the operation has been inferred from several sources. Largely from photographs, with established historical drilling practices, available first and secondhand accounts, and experience in the drilling industry as well (Sprague & Henwood, 1968) (Acker, 1974). When Sprague & Henwood mobilized a drill and crew to the location, they had brought a truck mounted 142-C model diamond core drill - the heaviest duty rig in their fleet. There are few records on who from the firm was involved. It is known that Nicholas Holly was a crewmember present. His daughter recalls him showing her core samples from the diamond drill (Monitz, 2013).

The scope of these first boreholes would be primarily to locate the men and determine if they were alive. A secondary goal was to allow passage of fresh air, food and water, as had been done in other cases prior (Ross, n.d.). Another secondary objective was to recover core samples to determine the structural stability of the overlying strata. Smaller diameter boreholes could be drilled faster than those by the rotary drill and the situation called for the miners to be located as quickly as possible.

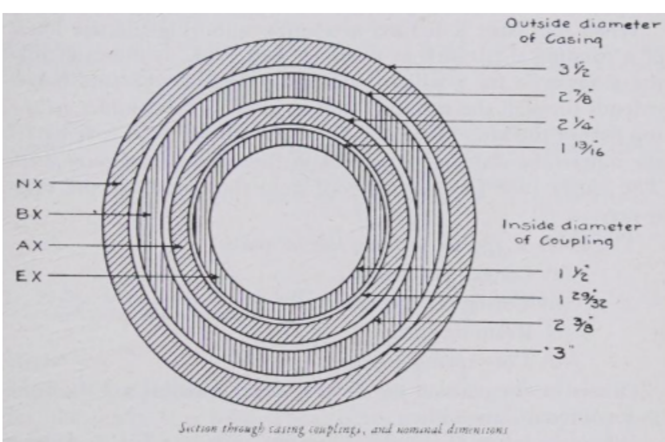


Fig. 32 Section Showing Nesting of Flush Coupled Casings.

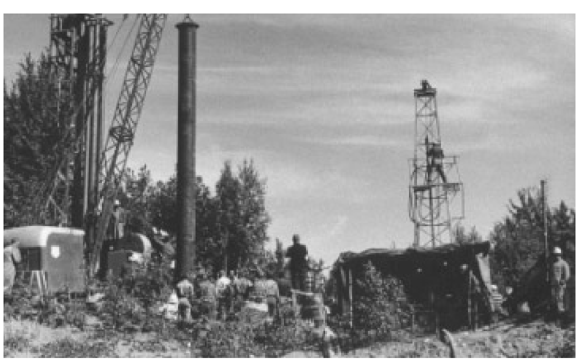
With the diamond core drills, casing would be first driven through the soil with a hammer. Periodically the casing would be cleaned out by drilling because it would fill with soil (Acker, 1974) (Sprague & Henwood, 1968). Whenever possible, a hole would be drilled ahead of the casing to make the driving operation easier. Typically casing sizes in core drilling at this time would be 3” and 4” so 6” was larger than typically used, but not unheard of.

Generally drop hammer weights were 300 lbs, but it is likely that heavier was used with the larger casing (Acker, 1974). The reasoning to drill nominal 6” from the start is likely for the passage of food and water. It is possible, however, that the holes were pre-drilled with a 7” or 8” bit, and the casing set in the ground, with a few seating blows with the hammer. This is supported by photos showing that this was possible with the rescue borehole casing (Albany.edu, 2000). However a bit of this size would be pushing the capabilities of a diamond core drill in terms of torque load on the drillhead and being able to properly clear cuttings.

Another reason for starting the hole off at such a large diameter, should there be any reason for holes to be reduced (ex, such as caving in) that may be accomplished. Sprague & Henwood had flush joint casing in inventory that could be lowered down the 6” borehole and continued as a 4” hole. This could still permit the passage of food and water.

After the casing was seated into rock, it seems that a large diameter series 4” by 5-½” core barrel was utilized to advance the borings. With accounts indicating the boreholes to be 6” in diameter, and mentioning core samples being taken from site, evidence points to this conclusion (Monitz, 2013). The use of larger core barrels in situations where only a hole is required is not unprecedented. In grout hole drilling, small air powered drills have been used with core barrels 3 sizes larger than intended for making a hole as this approach is more productive than a non-coring bit cutting the full surface area in the hole (Sprague & Henwood, 1968).

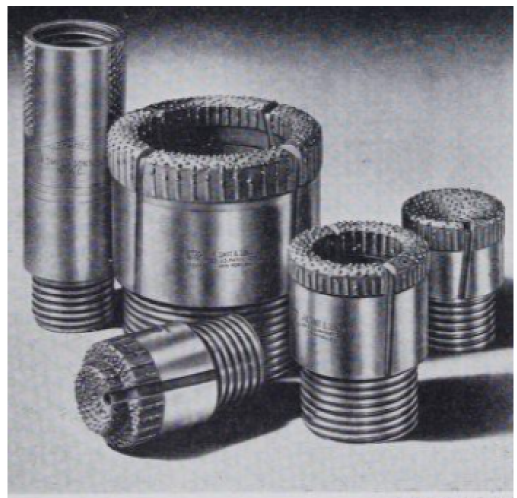
Photographs seem to suggest that air was used to clear the cuttings from the borehole. Several show clouds of dust around the core drill, air hoses laid out, presence of auxiliary compressors, and the water pump on the deck of the truck does not seem to be in use (Underground Miners, n.d.). Using air as a flushing agent while core drilling appears to have been a standard practice used on occasion at Sprague & Henwood and is still used on occasion to this day (Sprague & Henwood, 1968). Use of water could run the risk of flooding the void where the men were trapped.



Every length of the core barrel, the rods would have to be removed from the borehole so the core could be extracted before drilling continued. Photographs again show the driller’s helper in the crow’s nest on the derrick handling rods during a trip in or out (Albany.edu, 2000). The longest length of core barrel possible with this drill and derrick configuration is likely 20ft. It is reported that the 6” hole took 28 hours to drill with an hour and a half time to trip the rod out (Jackson, 2013). At this rate, they would have averaged over 11 feet an hour, which is extraordinary considering they had none of the modern conveniences that modern drillers have.

For the smaller 3” hole to attempt to contact Bova, similar methods would likely have been utilized with the replacement of the 4” by 5-½” core barrel by a more common NWG or NWM series (Acker, 1974). This style of core barrel would be a nominal 3” hole with a 2-⅛” core diameter. 3” flush joint or 4” heavy wall casing would have been driven with a 300 lb hammer (Sprague & Henwood, 1968). This would have been the standard size tooling for exploration drilling, and still is in common use to this day.

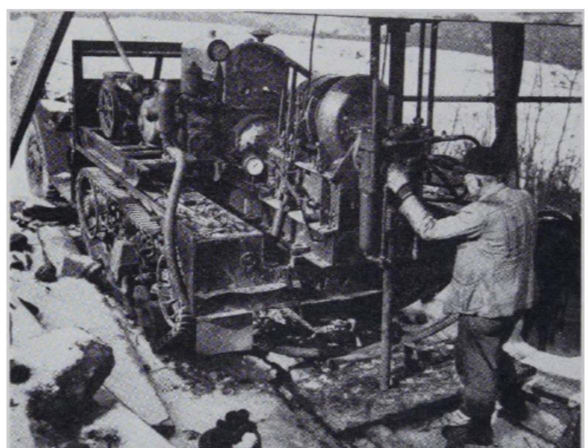
Alternatively, since the Sprague & Henwood 142-C drills were better suited for smaller diameter holes, there is a possibility that this was done with a non-coring bit. Perhaps a 3” tricone roller bit - this would have been identical but smaller than the bit used by the Bucyrus 50-R. The other option would have been a non-coring diamond bit. These were available in several styles.



J. K. Smit & Sons,

Fig. 37 Drill Bits of Various Types and Reaming Shell.

Non-coring diamond bits offer the advantage of speed, as the core barrel does not need to be removed from the hole and emptied every 10-20ft. It also tends to produce a hole with less deflection than a rotary bit, and the surrounding bedrock will be less disturbed. Additionally, not nearly as much weight on bit is required to advance the hole. Several bit crowns/shapes were available and it is likely a concave crown was selected due to local geology (Acker, 1974).



Sprague and Henwood, Inc., Scranton Pa.

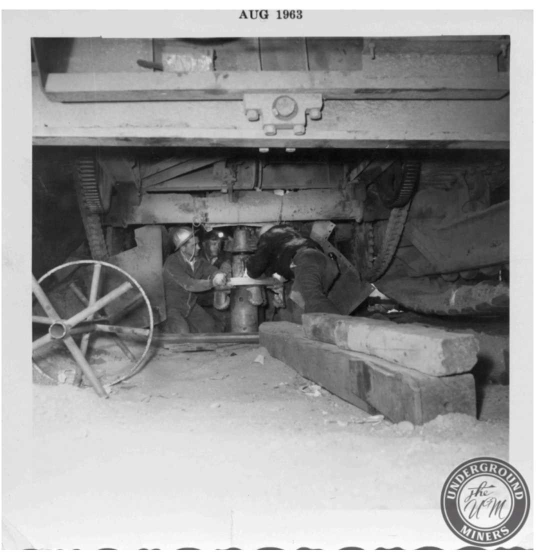
Fig. 91 Coal Coring near Tamaqua, Pa. Hydraulic Head Drill.

When coring tools were utilized, core samples of the bedrock drilled through would be available for inspection by the drillers, geologists, and engineers. From this representative sample much information could be learned about the condition of the overlying bedrock above the void. This is the primary use of diamond core drilling in a geotechnical context (Acker, 1974) (Sprague & Henwood, 1968). The depths of each different layer of coal or bedrock would be known to within an inch, as well as the exact composition of each layer. Additionally any natural fractures could be observed and logged. All this information is used by engineers to determine the structural stability of the overlying rock and possibly identify any risks or complicating factors. As an added bonus, when it came time to drill the rescue borehole, the driller operating the 50-R would have an idea what drilling conditions to expect and how deep and prepare himself and his equipment.

<u>The Rescue Borehole</u>

The presence of Pagnotti's Bucyrus 50-R drill meant rescuers had immediate access to a drill capable of making large diameter holes. They would be pushing the limits of the drill. It was intended initially for boreholes 12" in diameter to 100ft depth, this would be 3 times deeper and about 30% larger (Lang, 2010).

Again much has to be inferred from photographs, but news coverage has provided more details about the drilling process. The rotary drill works by pushing its weight on the bit as it's advanced, grinding up the bedrock. The process is more or less similar to standard rotary drilling, except in the reaming and casing operations (US Army Corps of Engineers, 2001).



A 12" bit was used for the rescue attempt to drill a pilot hole to reach the men. Afterwards it seems that a first reaming operation was performed with a commercially available reamer (Dino, 2010). Concurrently, a reamer was being fabricated by Bear Ridge for widening the hole to full gauge for the men (Schreppel, 1998). Compressed air from the drill was used to clear the cuttings from the hole. This 12" hole was advanced through soil and bedrock until the men were reached. At this point, supplies that would not fit down the 6" hole were lowered in.

Bear Ridge was tasked with custom producing a reamer to widen the hole to full gauge. This reamer consisted of a steel plate of about 17" diameter affixed just behind the bit, with several roller cones welded on the outer edge (Underground Miners). As the 12" bit followed the pilot hole, this reamer would enlarge the hole. The reamer was produced in 6 or 7 hours, according to Ted Kaliher (Schreppel, 1998).

Prior to the reamer being advanced, a plug was installed at the bottom of the borehole. This would prevent any drill cuttings from falling in the void and ensure the miner's safety (Schreppel, 1998). After the reamer was advanced to bedrock, it appears that some 18” casing was installed with a crane to prevent any soil caving in (Albany.edu, 2000). To do this with the blasthole drill, it had to be pulled off the hole, casing lowered in, and set back up over the hole. Blasthole drills do not typically have accommodations for casing handling, while well drills usually do.

The reamer was then advanced slowly through the bedrock. This was done because at faster rotational speeds, the hole would have rough edges that may cause lacerations. Also this had the effect of keeping the hole straighter. Some rescue capsules to carry the miners out were being designed and built and hole straightness would be vital to their use. Ultimately this idea was abandoned.

At the bottom of the hole, any cuttings that fell had collected on top of the plug. After the bit proceeded through the plug, efforts to hoist the men out could be started. The drill would be pulled off the hole once again so the hoist could be set up. The casing was left in the ground. After the capsule idea was abandoned due to concerns of hole straightness, coveralls had parachute harnesses sewn on, and these were used to pull the men to the surface with a hoist (Buckley, 1963).

Conflicting Accounts & Closing Thoughts

In my research efforts I’ve come across many different variations in the retellings of the events, which has made it difficult at times to understand the series of events. I am unsure why some details seem to vary, and there’s a chance that it could be as simple as the media not understanding or simplifying technical aspects.

The first conflicting detail I found was the depth of the borehole - some accounts say 300ft, some say over 300ft, one 308ft, some say 330ft, some even say 320ft. This could be due to reports saying “over 300ft” and eventually that being simplified to 300ft in retellings. There could also be mix-ups between borings, as it seems two had reached the miners - first a 6” hole, and then a second 12” hole. Since the men were on a slope, the roof and floor elevations varied in the void. Also, were the boreholes measured to the top of the void, or to the bottom?

Personally I initially believed the 330ft figure. In the article about Bear Ridge it’s said that ten drill rods, 32.75ft long each, were required. This adds up to a string length of 327.5ft. The length of the reamer assembly accounts for 4ft, for a total string length of 331.5ft. There is no measurement given for the length of the bit, but tri-cone roller bits are roughly as long as they are wide, not counting the length of the box or pin threads. This would add another 1ft to the string length for 332.5ft. Now when the drill string is tripped out of the hole and the first length is attached to the drill head with a bit and reamer, it’s very possible the bottom of the bit could be suspended 2.5ft above ground.

That being said, the 320ft figure is still possible, but I think this could possibly be an underestimate. Another length of 32.75ft drill stem would still be required to reach this depth and with the reamer would give a string length of 332.5ft. However, the length of the reamer would not be a factor during the drilling of the 12” pilot hole. So the string length without the reamer would be 328.5ft. We know that this bit first reached the miners, and then the hole was reamed out to permit their passage. Since in photos the reamer is shown being lowered into the hole, we can safely assume, with the drill head at its upward position, that the reamer and a length of drill steel can fit under the drill head, giving an account for space between the drill head and top of ground of 4ft. The 12” bit appears to already be below grade in the hole. Taking the 328.5ft string length, subtracting the 4ft to account for the reamer, my best estimate to actual depth would be around 324.5ft. There could still be some errors as it is not recorded how much “rod stickup” there was when the reamer reached the men, but with a depth around 324.5ft, it would also make sense for the media to either round that number upwards or downwards in their reporting, giving both the reported 330ft and 320ft figures.

Another point of discussion is Howard Hughes' involvement. Some accounts say that he provided a bit large enough because his company was the only company capable of. However I don’t think that to be the case. The Bucyrus Erie 50-R was intended to drill with 12” bits. It’s not improbable that Pagnotti already had a 12” bit in inventory with the drill. Bear Ridge seems to shine some light on this, as according to them, Hughes provided “drill extensions” (likely referring to roller cone assemblies shown in photographs of the reamer), and these were used to build the reamer. However one photo shows a reamer with approximately 12” bit on site, so perhaps this could have been provided. This also leads me to believe the reaming operation was done in two stages. Informal retellings say that Hughes provided diamond bits as he had the only company capable of but this is blatantly false - Acker Drill and Sprague & Henwood were both manufacturing and making advancements in diamond bits in the area for decades at this point. Sprague & Henwood had even proved the concept of “oriented” diamond bits, where the hardest part of each stone faces the direction of cut. Hughes’ largely focused on rotary bits for oil and gas usage. While Hughes’ contribution is appreciated, for the sake of historical clarity it’s more accurate to say he provided components for the reaming operation, and the tool itself was built locally in Pennsylvania.

In all of my research, there have been several variations in hole diameters mentioned. I believe this is because the press is referring to nominal hole diameters. For the diamond drilled holes, minus the hole to attempt to contact Bova, 6” casing was likely utilized as it is large enough for a 4” by 5-½” core barrel to pass through. This would also permit hole size to be reduced if needed with flush joint casing - a common practice in mines. Each string of flush joint casing would reduce hole diameter by about an inch.

With the rescue boring, the diameter has been referred to 18”, with some accounts saying 17” or 17.5”. Casing is known to have been used thanks to the photographic record. It’s my inference that 18” pipe was used as casing, and this being the nominal size. The actual inside diameter of this could have varied, depending on wall thickness. A quarter inch wall pipe would provide an inside diameter of 17.5”, and it’s likely the reamer was undersized from this as much as 17”. This could explain the different hole diameters being mentioned by various sources. There was likely some level of “bit walking” on the bottom of the hole in the overburden, which would enlarge the hole while having a bit small enough to pass through the casing.

As to the question of whether the disaster could have been prevented, I can not answer adequately. Mine maps from the era show areas nearby where cave-ins occurred, other sections with areas labeled “poor top”, these are clearly areas of poor structural stability. However the miners were fairly experienced men, perhaps it was their judgement that these were localized issues and did not affect the slope. We can judge the situation in hindsight, but we have information available that perhaps these men didn’t - or these men had information that we don't. As of now no cause for the collapse is known.

Perhaps the disaster could have been prevented - it was state regulations at that time that underground anthracite mines should have at least two entrances/exits. However there was an exception to this regulation that was in favor of smaller operations. In mines with one entrance, crews were allowed to rob pillars as long as they worked from furthest away back towards the entrance. The idea here being, if anything happened in front of the miners, they could retreat out of the mine. Unfortunately, a second exit was required in this situation, and that exit was installed after one man had already lost his life. Louis Bova should have never died in this incident, but another entryway into the mine could have possibly allowed rescuers to reach him. On the positive side, the Sheppton incident allowed a new method for rescuing workers just like him to be proven in trial by fire.

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