THE ADVANTAGES IN THE USE OF THE DIAMOND DRILL.

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Among the many duties the mining engineer is called upon to perform is that of "prospecting," or the examination of a territory for the purpose of estimating its value as a mineral land, and with a view of properly locating the necessary shafts, tunnels, etc., for putting upon the market the valuable minerals, if any such are found.

If the engineer is not already familiar with the geological structure of the country, he must, by consultation with those who are, and the examination of the results of geological surveys and such data as are furnished so liberally by the different State Departments, make himself familiar with the different strata and their characteristics, location and dip.

The prospector having then a general knowledge of what should be found in a particular location, now seeks to learn more precisely and accurately of the quantities and qualities of the different ores, rocks, clays, coals, etc., as they actually exist. This knowledge he must gain by personal examination, with the aid of drifts, tunnels, bore-holes or shafts.

The bore-hole I consider one of the most valuable aids the engineer can have in determining the nature and location of the different strata. The machine now most in use in drilling holes of a moderate depth in the rocks is the "Spring-pole Drill."

A rough derrick is built over the site of the proposed hole, and a crab or windlass rigged to it; the "Spring-pole"—generally a young hickory tree, of twenty-five feet long—is fastened at one end to the ground, and the other is brought under the centre of the derrick.

The pole is inclined at an angle of about 40° from the horizontal, and is so arranged that its elasticity will lift the drills after each stroke. The up and down motion is imputed to the drill by men, from three to five being needed, according to the depth of hole.

The necessary tools consist of a heavy "sinking-bar," to which the drills are secured, three or four drills or bits, two or three iron rods, about ten feet long, with male and female screws at the ends, and a sufficient number of wooden rods fitted with screws to reach the required depth of hole.

The bitts should be made to bore a hole about 2½ inches in diameter, and as they require frequent sharpening by the blacksmith, a guage should be used to detect any variation in zize.

After removing the surface earth from the rock, either by shovel or a tool similar to a post-auger, the hole is started with drill and sledge until of sufficient depth to hold the drill steadily in place.

The men at the free end of the pole—on a platform in the derrick about twenty feet from the bottom—give an up and down motion to it, which is communicated to the drill by a rope passing through a swivel on the end of the drill rod—the "spring" of the pole assisting the men on the rebound of the drill.

Water is poured into the hole and holds the fragments of rock broken off by the bit in suspension, permitting the cutting edge of the bit to fall on a clean surface of rock at each blow.

At each stroke of the drill a man, the "boss driller," turns it about a quarter round, thus making a round hole. At certain intervals the drill is lifted from the hold by the windlass and rope passing through a match block at top of derrick, and the water with sediment is pumped from the hole with a "sludge pump," consisting of a long bucket with standing valve in the bottom attached to a small rope.

The sediment contained in the water is carefully collected, dried and preserved in labelled vials, it being in most cases the only means by which we can judge of the nature of the material passed through by the drill.

No rules can be laid down for the speed with which the drill should be revoked to make a round hole, or the frequency with which the water should be pumped out. These would range with every different rock and mineral.

The results obtained by the use of the Spring-pole Drill are at best approximations the accuracy of which depends upon the skill and judgment of the boss drillers. His hands are continually clasped about the drill rod, and by the "feel," "jar," or "sound" he guesses he is passing form one stratum to another; the rod is measured, and he has the depth to—somewhere. The sludge-pump brings up its sediment; the sand rocks are easily shown by the granular sand; the shales would give the same result, but the boss "felt" when the drill entered and left that rock for the solid sandstone, and the drill rods "gave out a different sound."

Fine clay and limestone yield similar looking sediments, but by exposure to the air the former soon softens and has an unctuous feel to the finger, and a drop of sulphuric acid applied to a supposed limestone readily shows its character.

In the ores exposed by the drill hole but little difference can be detected in quality, and no analysis of value could be made on account of the impossibility of preventing the minute fragments of the strata from intermingling.

In passing from the black slate to the coal, and through the different "partings," it is impossible to make accurate measurements, and the drill, pump and boss combined can only give *about* so much slate and coal to the fire clay.

Notwithstanding the uncertrinty attending the use of the Spring-pole Drill, in charge of a trustworthy and experienced man, it has been and will be of great assistance to the mining engineer and prospector.

The tools and material are not costly. A complete rig for boring about one hundred feet may be had for $100. A good blacksmith can make and keep the bits in repair, but the aid of a screw cutting lathe is required in repairing the connection screws.

The cost of boring holes to a depth of one hundred feet on the Ohio and Western Coal and Iron Company's lands in Floodwood, Ohio, was about seventy-five cents per foot, including the surface boring.

In 1863, Prof. Rudolph Leschot, a civil engineer, native of France, made the first successful application of diamonds to the miner's art and practical rock drilling. Since then many improvements have been made, until now we have a machine for prospecting and mining purposes which is nearly perfect; and by its use we can give the property owner positive information as to the direction, width and value of any vein of ore or valuable mineral in advance of development, so that shafts and tunnels may be accurately located, and a plan for future work laid out with certainty.

This machine is called "The Diamond Drill," and consists of an annular or "cored" bit, with a hollow shaft attached by suitable gearing, to a portable engine, capable of making from two hundred to a thousand revolutions per minute.

An attached pump supplies a stream of water which is forced through the hollow shaft and bit, thence up out side the shaft, carrying with it all the detritus made by the cutting diamonds imbedded in the bottom of the bit.

With this drill holes can be bored at any angle from horizontal to perpendicular, perfectly round, straight, of any diameter, and to any depth.

There are two kinds of diamonds used in pointing the "bits," and are technically known as "carbons" and "borts."

The former resemble in size and shape small irregular pieces of gravel, and are of a dark brown color, almost black, and dull on the surface like lignite.

The "bort" is the diamond of commerce, which from its imperfections, is thrown aside by the jeweler. These are nearly spherical in shape and generally set on the outer edge of the drill, as from their form they are not so liable to catch into the seams, etc., of rocks, as the angular and irregular shaped "carbons."

The bottom of the "annular bit" is a steel thimble, having three rows of diamonds (carbon and borts) imbedded therein, so that the edges of those in the center row project from its face, while the edges of those on the outer rows project from the outer and inner peripheries respectively.

The diamonds of the first mentoined saw cut the path of the drill in its forward progress, while those upon the peripheries enlarge the cavity around the same, and admit the free ingress and egress of water, as before described.

In drilling holes for blasting purposes, when it is not deemed necessary to preserve a specimen core of the rock, a "perforated" or "solid" bit is used. This bit produces the ordinary hole commonly used in rock drilling, it being pulverized by the revolution of the drill.

The water passes through the perforations made in the steel head holding the cutting diamonds, in sufficient volume to answer the same purposes which are provided for in the annular bit.

The preliminary work for drilling with this machine is similar to that of the Spring-Pole Drill. The surface ground having been removed to the solid rock, if possible, a derrick is erected from twenty-five to fifty feet in height, according to the depth of the hole to be drilled. The shaft holding the bit is then directed to the proper angle, made to rotate, and at the same time is fed forward by a screw shaft, cutting an annular channel through the rock.

That portion encircled by the channel is, of course, undisturbed; a core barrel passing down over it preserves it intact until the rods are withdrawn, when the solid cylinder thus formed is brought up with them, the "core-lifter" breaking it at the bottom of the hole, securely wedging and holding in the core barrel.

The machine is so arranged that when it becomes necessary to withdraw the rods from the hole, they are uncoupled below the chuck which holds them, and the chuck and swivel head—which is hinged—is swung bodily one side, and affords a clear passage for the rods without changing the position of the machine.

A hoisting gear on the machine does the lifting, and the derrick can be made high enough to avoid breaking joints, only in every forty or fifty feet.

The person in charge of the drilling need not be an expert, but should be an intelligent mechanic, familiar with the power of steam and its management, capable of running the engine, and making all necessary repairs.

The wearing off of diamonds is almost imperceptable, and the cost has been estimated at about seven cents per foot for granite and the hardest rock. Having no record of holes bored in the soft sand rocks of the bituminous coal measures, no fair comparison can be made with the work done by the Spring-pole Drill.

The first cost of the Diamond Drill is a great drawback to their general use by the mining engineer and prospector, although it would seem to be a most excellent investment for the investor and operator.

A "Prospecting Drill," attached to an upright tubular boiler, that is capable of boring to a depth of one thousand feet, weighs 4,000 pounds, bores a two-inch hole, and furnishes a core one and three-eighths inches in diameter.

The outfit accompanying this machine consists of one diamond bit, two blank bits, core-lifter, core-barrel, two hundred feet of drill rods, steam pump, water joint and hose, lifting jack, and a complete set of tools for operating the machine and keeping the bits in order. This will cost $4.000.

A "Shafting Drill," especially adapted for long hole boring in shafts, will weigh 1,000 pounds, and is furnished with the same fittings except that the bit is a "solid perforated," boring from 1¾ to 2 inches in diameter. This costs $1,000, and does not include the power, which may be of steam or compressed air.

In sinking shafts by the use of the solid bit, all the holes necessary may be bored directly to the bottom, at grade, before any blasting is done. The holes may then be filled with sand, leaving room at top to put in the first charges of explosives used, which may then be fired simultaneously. After removing the broken rock, enough sand is scooped from the drill holes to admit the next charge, this process being repeated to the bottom.

By this process more rock will be removed with a given amount of labor and explosives, and the work when completed would require less hand picking to make smooth walls—especially if the outer row of drill holes was made defining the proposed dimensions of shaft, than by any other method.

In 1883 The Hope Mining Company, of Philipsburg, Montana, with a prospecting drill similar to the one before described, bored 3,467 feet of hole, through limestome, in 596 hours, averaging 5′10″ of hole, per hour.

In 1884, with the same machine, they bored 3,467 feet in 832 hours, through limestone, averaging 6′10″ inches per hour. In April, 1884, they bored 100 feet, through sandstone, in ten hours. In May, 381 feet in 29½ hours, through granite, and 109 feet in 10 hours, through quartz.

The cost of these holes did not amount to more than 41 cents per foot, and the machine was in just as good condition when the work was completed as when it left the factory.

During the month of February, last, at the New Orleans Exposition, two cores 1⅜″ diameter, were cut from a mass of Georgia corundum, one of 9¼″ in length in 8 minutes, and the other 4″ in length in 4 minutes and 7 seconds, and was accomplished without any appreciable damage to bits or appliance.

In the scientific scale of hardness, corundum is rated at 9, the diamond at 10, and except the diamond there is nothing harder.

The results obtained from the use of the different drills may be briefly summed up as follows:

For the Spring-pole Drill, a hole bored in the rock to the required depth, passing through and aproximately locating the different strata, and a few vials containing the pulverized rock and mineral brought up with the sand pump, more or less intermingled, from which an estimate is to be made as to the character and value of the ore, limestone, coal, etc., supposed to be located by the judgment of the man in charge. All these are obtained at a minimum cost for tools and skilled labor.

For the Diamond Drill we have a complete cylindrical core, a section cut from top to bottom of the hole. There can be no doubt about the quantity or quality of mineral, lime or coal through which we have bored. It lies before us in its proper place, and, it is hoped, correctly labelled for future use, and from it we may take specimens for chemical analysis or assay. Nothing is left for the imagination or biased judgment.

Used as a mining drill, we have the greatest speed and accuracy of direction, to any depth and reasonable diameter.

For sub-marine drilling it is indispensable, as by its use submerged rocks, twenty or thirty feet under water may be drilled and blasted without difficulty.

The Diamond Drill is therefore simple in construction and operation, seldom needing repairs, and will perform a given amount of work more cheaply than can otherwise be done.

While the Spring-pole Drill has its sphere of usefulness, and is of valuable assistance in science and manufactures, the Diamond Drill appears to satisfy all the demands of the Mining Engineer and Prospector, and the rapidity and economy of its work, and the accuracy of its results, should warrant the investment of the capital required in its purchase.

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[This paper was accompanied by a granite core about 6 inches long and 1¼ inches in diameter, taken by means of a Diamond Drill, from a depth of 240 feet. It was examined by members and others with great interest.]