OHIO GEOLOGY

GEOFACTS No. 15

OHIO DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

COAL MINING AND RECLAMATION

Coal has been mined in Ohio since 1800. Although evidence of coal mining can be seen at many places in eastern and southeastern Ohio, few individuals have actually seen how coal is mined to understand the effort and technology that is involved in extracting the resource from the ground so that it can be used.

There are two basic methods of mining coal: surface mining and deep or underground mining. Since 1800, 3.6 billion tons of coal have been mined in Ohio. This tonnage includes 1.4 billion tons from surface mines and 2.2 billion tons from underground mines.

SURFACE MINING

Surface mining in Ohio was first reported in 1810 from a ravine located 1 mile west of Tallmadge in Summit County. Early surface mining in Ohio consisted of digging coal that cropped out along hillsides, using picks and shovels and in some cases horse-drawn scrapers. The coal and cover material were excavated back into the hillside, perhaps 10 feet or more, until removal of the cover material was too impractical or too difficult. At this point, coal mining continued using underground methods.

Mechanized surface mining began in Ohio during the 1880's in conjunction with the construction of railroads. However, surface mining remained minimal until 1914, when large amounts of coal were needed as fuel for World War I. By 1948, surface mining became the dominant method by which coal was produced in Ohio and remained the dominant method until 1995, when more coal was produced in Ohio by underground mining.

In general, surface mining is the most productive, fastest, and least expensive method of extracting coal from the ground. This method is used where coal seams lie close to the surface. Surface mining involves removing layers of soil and rock (overburden) above the coal seam and extracting the coal.

Before mining can take place, a permit must be obtained from the Ohio Division of Mineral Resources Management. Vegetation is removed, and then topsoil and subsoil are removed by bulldozers and earthmovers and stored on the mine site for use in reclamation. Bedrock is loosened by large bulldozers equipped with claw-shaped rip-blades or by blasting. Bulldozers rip up rock that is easily broken such as shale or a highly weathered or poorly cemented rock. However, competent rock (rock that is inherently strong), such as limestone or a well-cemented sandstone, is not easily broken up and requires blasting. During the blasting process, many closely spaced holes are drilled to a depth that is just above the coal seam. These holes are loaded with explosives and are carefully detonated to fracture the rock and minimize the amount of fly rock (rocks or rock fragments that are thrown and scattered by the explosive force of a blast). Bulldozers, front-end loaders, and, to a lesser extent, large power shovels or draglines move the loosened bedrock to expose the coal in a highwall (a manmade cliff on the uphill side of the excavation). The bedrock is dumped in rows, called spoil piles, behind or adjacent to the highwall. Smaller power shovels or front-end loaders load the coal into trucks, which move the coal out of the mine.

The floor of the excavation is called a pit or bench. Surface mining advances sequentially in a series of pits across the mine site until all the coal has been mined. The bedrock overburden excavated from each pit is used to backfill the preceding pit to its approximate pre-mining contour. Stored subsoil is used to cover the spoil and is in turn covered by topsoil. Finally, the area is revegetated with grasses and/or legumes and at some sites with trees.

Approximately 80-90 percent of the coal can be recovered by surface mining. The economic limit of surface mining in Ohio is generally a 20:1 ratio of overburden thickness to coal thickness. For example, a 3-foot-thick seam of coal can generally be surface mined economically at an overburden thickness up to 60 feet. However, there are some surface mines in Ohio where a highwall up to 200 feet high has been made to mine a 5-foot-thick seam of coal. To produce these very tall highwalls, some of the largest surface-mining equipment in the world, such as the "Big Muskie" dragline and the "Mountaineer" shovel, were used.

UNDERGROUND MINING

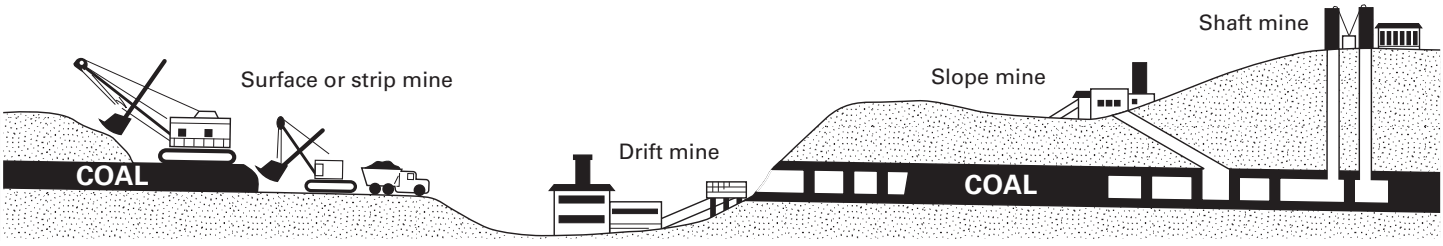
From 1800 to 1948, the principal means of mining coal in Ohio was by underground methods. There are three types of underground mines, named for the type of opening used to gain access to the coal. Drift mines use a horizontal opening to mine coal that occurs above stream level. Shaft mines use a vertical opening and slope mines use an inclined opening to reach coal at great depth or below stream level. The deepest shaft for mining coal in Ohio is the now-abandoned Jensie mine in Jefferson County at a depth of 480 feet. The deepest slope opening in Ohio is the Nelms-Cadiz Portal, operated by Harrison Mining Corp. in Harrison County, used to reach coal under 530 feet of cover.

Most underground mines in the U.S. use the room-and-pillar method of mining. A series of rooms are cut into the coal bed and pillars of coal are left for roof support. Wooden timbers and roof bolts are used as additional supports. As room-and-pillar mining advances, a gridlike pattern is formed. Typically, rooms are 20 to 30 feet wide and up to 400 feet long. Pillars are 20 to 30 feet wide and 90 feet long. In this style of mining, generally 50 to 70 percent of the coal is recovered and the remainder is left as roof support. In Ohio, 42 inches is generally considered to be the minimum coal thickness for economic underground mining. However, the Sterling mine in northern Jefferson County is mining coal underground which averages 35 inches thick.

The most common type of room-and-pillar mining is continuous mining. It accounts for about two-thirds of the output from underground mines. In continuous mining, coal is cut by a machine using a rotating cylinder studded with tungsten carbide bits. The coal is then loaded onto a shuttle car or conveyor and carried to the tipple, where it is loaded for shipment.

Another type of room-and-pillar mining, not presently used in Ohio, is termed conventional mining. In conventional mining, the base of the coal is undercut laterally along the working face and several feet into the coal. The undercutting is done by hand using a pick or by coal-cutting machinery. Until the advent of coal-cutting machinery in Ohio in 1889, coal was undercut entirely by hand. Once the coal is undercut, holes are drilled into the seam along the working face. The holes are filled with explosives and detonated. As in continuous mining, the loosened coal is then carried to the surface.

Another method of underground mining, which is becoming more common in Ohio, is longwall mining. The coal is mined from one



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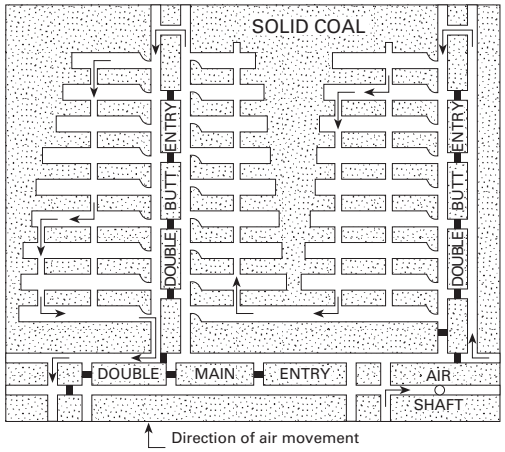

Plan view of idealized double-entry room-and-pillar mine layout (from Crowell, 1995, p. 37).

long face—the longwall. The area to be mined can be up to 14,000 feet long and 800 feet wide, as in the Ohio Valley Coal Co. Powhatan No. 6 mine in Belmont County. In longwall mining, a machine with a revolving cylinder studded with tungsten carbide bits moves back and forth across the working face, shearing off chunks of coal, while water is sprayed on the coal to minimize the amount of coal dust generated. Just as in continuous mining, the coal falls onto a conveyor system or is loaded onto underground rail or shuttle cars and carried to the surface. In longwall mining, moveable steel supports hold up the roof over the immediate working area. As the mining machine moves forward, steel roof supports advance with the machine, allowing the roof in the mined-out area behind the supports to collapse in a controlled and predictable manner. Nearly 80 percent of the coal can be removed using this method. This technique has significantly increased productivity and reduced costs so that underground mining is able to remain competitive with surface mining.

AUGER MINING

Another type of coal mining used in Ohio is auger mining, which is a combination of surface and underground methods. In auger mining, coal is extracted by drilling horizontal holes as far as 500 feet into the seam using screwlike augers, which resemble giant drill bits and are up to 5 feet in diameter. Auger mining is used when it is not feasible to extend a highwall beyond a 20:1 surface-mining limit.

EFFECTS OF MINING

By necessity, surface land is disturbed in the process of mining coal. The area of the disturbed land can range in size from a few acres to tens of square miles. However, the ecological and environmental impact of unregulated and unreclaimed mined land can reach far beyond the limit of mining as a result of (1) streams choked by ex-cessive sediment loads, (2) acid mine drainage, and (3) subsidence.

Spoil that is produced during mining consists of crushed rock. Spoil contains no humus, lacks nutrients for plant growth, and has poor moisture retention. Therefore, spoil piles support little or no vegetation, provide no cover for wildlife, and are easily eroded if left unreclaimed. Sediment loads of streams that are fed by eroding spoil piles can be increased by as much as 1,000 times. Thus, these streams can be easily choked, causing stream valleys to fill in, creating wetlands where none existed before.

In addition, unreclaimed spoil piles generally contain pyrite-bearing rock and coal. Pyrite is iron disulfide (FeS_2), and when it is exposed to oxygen and water, especially in the presence of *Bacillus ferroxidans*, a pyrite-oxidizing bacterium, it produces sulfuric acid ($2H_2SO_4$). Streams carrying acid mine drainage commonly have a reddish or yellowish sediment coating on their bottoms or on objects lying in the stream. This coating, called yellow boy, is an iron sulfate precipitate (Fe_2SO_4).

Some controversy surrounds underground mining owing to the impact of surface subsidence (see GeoFacts No. 12), especially in residential areas, such as Wellston (Jackson County) and North Canton (Stark County), that have been built over long-abandoned mines and are experiencing mine-subsidence problems. In addition to subsidence, abandoned underground mines are a safety concern. When openings (drift, slope, hoisting shaft, and air shaft) are not sealed upon abandonment, these openings become attractive nuisances. Some people, and hapless animals, may wander through these openings to explore inside the mine and the result can be deadly. The atmosphere in an abandoned underground mine may be unfit or poisonous to breathe and the condition of the roof rock may be so deteriorated that collapse can occur without warning.

RECLAMATION OF MINED LAND

Reclamation is a process of systematically restoring mined land to productive uses, a kind of landscape plastic surgery that transforms former coal mines into productive, attractive, and useful areas. Until 1947, when Ohio's first surface-mining law was passed, surface mining was unregulated. Coal companies were not required to restore the land they altered in mining. Some companies made limited attempts at reclamation long before any law required it. But many companies did not practice reclamation because the cost of reclamation was not considered justifiable from a business standpoint. In 1949, the Ohio Division of Reclamation (now the Division of Mineral Resources Management) was created and charged with administering the new reclamation laws. Ohio's early surface-mining laws were weak in some respects and resulted in a lack of demonstrated progress in restoring surface-mined land. These laws required the posting of a modest reclamation bond of $100-$200 per acre mined and did not require the establishment of successful vegetation on mined lands; therefore, great amounts of fertile topsoil were lost through erosion. However, Ohio's surface-mining law was amended many times and in 1972 became one of the nation's strictest laws regulating active surface mining.

Before a company may begin surface mining, it must specify how topsoil, water conditions, vegetation, wildlife, and archaeological resources will be protected, in addition to outlining how the land will be mined and reclaimed. Also, the coal company must post a bond of $2,500 per acre to insure that successful land restoration is carried out. Among the many requirements of Ohio's mine law are: (1) restoration of coal-mined land to its approximate original, pre-mining contour, (2) concurrent reclamation, (3) establishment of successful vegetation which must be monitored for five years before bond monies are fully released to the operator, and (4) repair and/or compensation for damages caused by longwall mining as well as making a pre-mining assessment of structures which may potentially be affected by longwall mining. Furthermore, for each ton of coal mined, Ohio coal operators pay federal and state severance taxes to be used in reclaiming abandoned mined lands. The federal severance tax is 35 cents per ton for surface-mined coal and 15 cents per ton for deep-mined coal; the state severance tax is 9 cents per ton. Reclamation of abandoned mined lands can cost $10,000 per acre, whereas the cost of reclaiming land concurrent with mining is $1,000-$3,000 per acre.

Today's coal operator must comply with many regulations. However, in spite of increasing regulations and cost to today's coal operator to perform acceptable reclamation, numerous coal operators demonstrate that a business can be profitable and at the same time restore mined land to usefulness and productivity.

FURTHER READING

Crowell, D. L., 1995, History of the coal-mining industry in Ohio: Ohio Division of Geological Survey Bulletin 72, 203 p.

_____ 2001, Mine subsidence: Ohio Division of Geological Survey GeoFacts 12.

_____ 2001, History of coal mining in Ohio: Ohio Division of Geological Survey GeoFacts 14.

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Wolfe, M. E., 2001, 2000 Report on Ohio mineral industries: Ohio Division of Geological Survey, 153 p.

• This GeoFacts compiled by Douglas L. Crowell • Revised March 2002 •

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