Why Surface Mine?

By Gene Kitts, Senior Vice President-Mining Services, International Coal Group, Inc.

Why do we surface mine in Central Appalachia? It's certainly not because we like the public attention and we really don't enjoy the struggles with regulatory agencies, the years of permitting delays and the seemingly endless litigation. The fundamental answer is that coal is surface mined because that is the method necessary to recover the resource.

Starting with the basics

Why do we surface mine a coal seam or group of seams instead of deep mining that reserve?

The answer is generally determined by geology and topography. However, in many cases the coal reserve has been previously deep-mined and surface mining recovers what was left. Surface mining through abandoned deep mines, recovering the blocks of coal that were left decades ago, is relatively common. Contour mining along the outer boundary of old deep mines has been a widespread practice for years. The advent of the highwall miner, which is a more productive successor to a coal auger, has encouraged this trend.

Back to geology and topography – how do these factors determine whether a seam is surface mined or deep mined?

Geology

Among the many geologic variables are coal thickness, expected mine roof conditions, and the vertical distance between coal seams. Some coal seams are just too thin to deep mine. Frequently, the rock overlying coal seams higher in a mountain is broken or unconsolidated, making the roof too weak to allow safe underground mining. Coal seams occurring too close together can make deep mining impossible. A coal seam that lies beneath the local valley floor ("below drainage") will not be a candidate for surface mining in central Appalachia but deep mining may be a possibility.

Figure 1 is a photo of an actual surface mine highwall illustrating the coal seams and intervening rock. Figure 2, which was taken from an exploratory drill hole on a surface mine project, shows the various types of rock and the coal seams that appear inside the mountain.

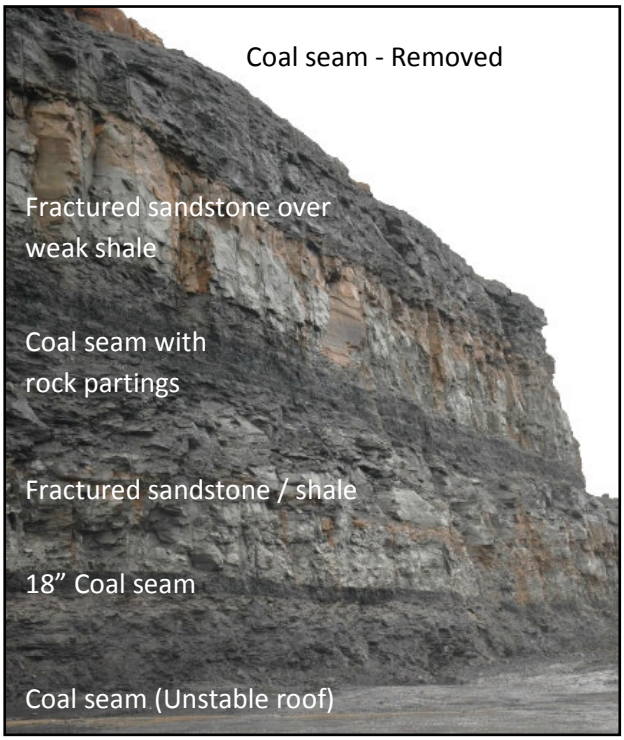

Figure 1: Surface Mine "Highwall" Showing Coal Seams

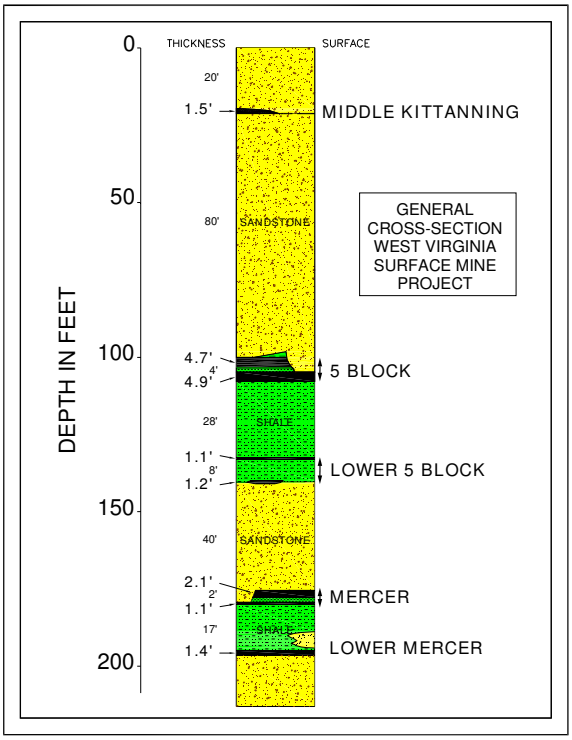

Figure 2: Geologic Column

Topography

Topography, or the shape of the land, determines the extent of a coal reserve situated above the valley floor. The ridgelines in central Appalachia are generally comprised of peaks and low gaps as illustrated by Figure 3, which is taken from mapping of an actual mine project.

A coal seam that lies just a hundred feet or so beneath such a ridgetop may only measure about 400 feet to 500 feet from one side of the mountain directly through to the other side, which is not sufficient width for deep mining. The Five Block seam shown in Figure 2 is thick enough to deep mine but at this specific mine site, the ridge is only about 200 feet to 400 feet in total width at the elevation of that coal seam. There’s simply not enough room to conduct deep mining in that area.

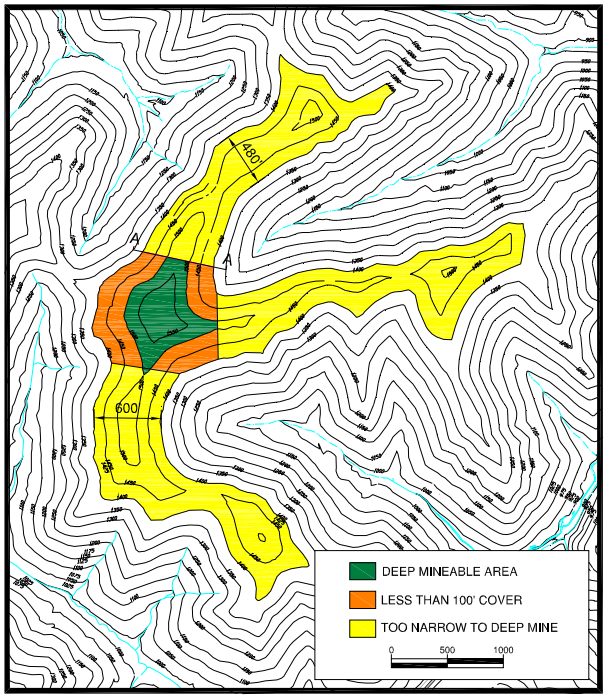

Figure 3: Typical Appalachian Ridgetop Reserve

So, how much width is needed to accommodate deep mining? An underground mine will have at least five parallel entries (tunnels) that are usually 20 feet wide and spaced no less than 50 feet apart center to center, which gives an overall width

of 220 feet. A barrier must be left intact along both sides of the mine to maintain ventilation, to control drainage and to support the overlying rock. Staying under at least 100 feet of solid rock ("cover") is the general rule of thumb for mine design, so if the typical hillside slopes at 30 degrees then each of those barriers would be just over 170 feet. Adding up the numbers, a minimal deep mine configuration would require 560 feet of width. Referring back to Figure 3, one can see that deep mining a seam that lies 150 to 200 feet beneath a ridge is not practical. Only about 10 acres (shaded green) of the 108 total acres highlighted would qualify for deep mining if all other factors (seam height, etc.) were favorable.

If deep mining is eliminated as an alternative, surface mining options may include mountaintop removal, full seam recovery with restoration to approximate original contour, or a combination of contour and highwall mining. Contour and highwall mining is typically the only practical surface mining method for seams found deeper beneath the ridge that are not amenable to deep mining (or have already been deep-mined.)

The economics of mining

Economics is a key consideration in mining, but it does not typically decide whether a coal seam is surface mined or deep mined; that is determined by geology and topography. Once the factors dictated by nature such as seam height and geologic setting have categorized a reserve as suitable for surface mining, economics generally determines the mining methods to be applied to that reserve. Three basic factors must be considered: (1) how many cubic yards of earth have to be moved to recover one ton of marketable coal (this relationship is commonly known as the mining ratio), (2) what is the total cost of moving that material, and (3) what is the sales price of the coal?

Mining Ratio: The mining ratio is outside the operator's control for a mountaintop removal project; that is, a fixed volume of earth overlies a fixed volume of coal. There is nothing a mine designer can do to improve the ratio if the full seam is to be taken. However, any reduction of marketable coal will increase the mining ratio. Any surprises, such as the coal being thinner than thought or the unexpected need to improve the coal's quality by "washing" in a coal preparation plant, will have a negative impact on the mine ratio.

For a contour or area mine, the ratio increases as the mine digs deeper into the mountain so the mine designer can adjust the depth and the corresponding volume of material that is being excavated. For example, using our 30 degree hillside again, a contour cut 100 feet into that mountain would generate about 106 cubic yards of earth per linear foot. Let's say we're mining a 24 inch thick coal seam and recovering 100% of the in-place coal (which is actually not possible.) We would get 200 cubic feet of coal, which is equal to 8.5 tons (at a perfectly clean 85 pounds per cubic foot.) So, our mining ratio would be 106 divided by 8.5, or 12.5:1. Now, to take a cut 150 feet deep, we would generate 239 cubic yards per linear foot and produce 300 cubic feet or 12.75 tons of coal for a ratio of 18.75. If the total cost to mine was $3.00 per cubic yard, the coal sales price per ton would have to be $37.50 to break even at the 12.5:1 ratio and $56.25 at the 18.75:1 ratio.

Mining Cost: The total cost of mining will include everything, starting from the beginning of the project to active mining and through land restoration to the final release of the mine permit and surety bond, which will be years after the last ton of coal is sold. Taxes, royalties, fees and all other costs of operations have to be covered in this cost per cubic yard.

Sales Price: Like most other commodities, the price of coal is set by the market. Electric utilities generally purchase coal on the basis of competitively bid supply contracts of one to three years duration. Price adjustments are made for coal characteristics such as ash and sulfur content and heating value.

A mine operator has little control over the sales price for its product, some control over the mining cost, and can sometimes adjust the mine plan to alter the effective mining ratio. Most Appalachian surface mines use combinations of mining methods such as mountaintop removal, area mining, and contour mining where appropriate to develop an effective and economical overall mine plan. Different types of equipment (rubber-tired loaders, hydraulic shovels, electric shovels, etc.) are matched to the specific mining application based on capabilities. For example, it's common to use shovels to excavate thick strata near the top of a ridge but use rubber-tired loaders due to their mobility to contour mine lower on the mountain. Striking a balance between the more expensive cost per cubic yard of the smaller equipment with the more efficient larger equipment is a key to successful surface mining.

Talking about jobs

Now, let's talk about jobs. It's popular among opponents of Appalachian surface mining to say that more miners would be employed if we stopped surface mining and switched to underground mining. It's true that surface mining is more productive than deep mining. Using Mine Safety and Health Administration (MSHA) data for the first three months of 2009, WV surface miners produced 3.99 tons per employee-hour compared to 2.94 tons per employee-hour for WV deep miners. (See page 16 at http://www.msha.gov/Stats/Part50/WQ/MasterFiles/MIWQ%20Master_20091.pdf) Simply stated, 120 surface miners could mine 1 million tons per year while 163 deep miners would be required to produce the same output (1,000,000 tons / tons per employee hour / 2080 hours per employee per year).

Let's imagine that a 10 million ton block of coal could actually be mined using either deep or surface mining methods. Surface mining would recover about 80% of the reserve, so 120 miners could work for eight years (960 employee-years) to produce eight million tons. Deep mining would recover about 50% of the reserve due to the requirement to leave pillars and barriers in place, so 163 miners would be employed for five years (815 employee-years) to recover five million tons. (See Glossary at page 69 of http://www.eia.doe.gov/cneaf/coal/page/acr/acr.pdf for definition of *Recovery Factor*.) Three million fewer tons would be mined and the equivalent of 145 jobs for one year would not be created. In addition, the overlying seams that are too thin or too close together or too near the top of the mountain to deep mine would be recovered by surface mining, so the actual tonnage and longevity of the surface mine would be greater. The

argument that deep mining creates more jobs simply breaks down when one considers all of the factors involved.

The economic impact of surface mining in West Virginia

It's also often quoted that surface-mined coal from Central Appalachia makes up only a small percentage of the nation's total coal production so we should just eliminate this form of mining. However, in 2008 Central Appalachian surface mining produced almost 131 million tons, or 11% of the 1.17 billion tons of U.S. coal production, not an insignificant amount. (See Table 3 at http://www.msha.gov/Stats/Part50/WQ/MasterFiles/MIWQ%20Master_20084.pdf)

West Virginia surface mined 69 million tons of coal in 2008, so using a conservative guess of $50 per ton for the average sales price, the state's 5% severance tax alone generated $172.5 million, which again is not an insignificant number in the state budget (http://www.wvsto.com/Tax+Distribution/Coal+Severance+Tax.htm).

The 6,164 surface mine workers (per MSHA records) in West Virginia who were directly employed at the mines producing that tonnage probably consider themselves and their families significant also. And, let's not forget the thousands of indirect jobs that are supported by surface mining. The folks who sell and service mine equipment, prepare and monitor mine permits, plant trees, sample water, sell and deliver fuel and supplies, haul coal by truck and rail, and even the attorneys who provide legal services, all consider themselves significant.

That's why we surface mine – it's not easy, it's not cheap, and it's not quick but it's the method that works to produce over 40% of Central Appalachia's coal output.