TOPIC 1
The Coal Industry

Quick Find

Before we examine the details of mine site practices and procedures, it is useful for you to gain an overview of the coal industry including the formation of coal, the methods of mining coal, the preparation of coal, and coal marketing. This will enable you to see how the work you will be doing affects the overall operation of the mine site.

1. THE FORMATION OF COAL

Most of the black coals mined and processed in Australia were formed in the Permian period which occurred between 220 and 290 million years ago. Essentially, coal is the product of forests that existed at this time. As the plant matter died, it fell to the swampy forest floor where a process of decay began. Over time, the decaying vegetation was chemically changed until it became peat. With changes to the earth's surface and weather patterns, peat bogs could either be flooded or dried out.

When they were flooded, silt and sand were deposited in layers over the peat. Ultimately, the compressing force of the layers of mud and sand turned the peat into coal. In some cases, new forests grew over the existing coal/peat beds and the coal formation process was begun again. Thus we can see that coal occurs in seams 'sandwiched' between layers of rock and dirt. Sometimes movements in the earth have caused the seams to tilt, resulting in seams of coal that run at an angle to the surface. Naturally, it is the coal seams themselves and not the rock that are the valuable resource.

As well as the fact that coal occurs in seams, it is also important to realise that there are several classifications of coal. The classifications reflect a variation in the coal's maturity. Maturity is affected mainly by the depth at which the coal has been buried. In general, the deeper coals are the more mature.

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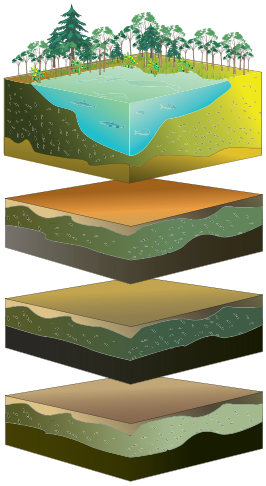
The main ranks of coal are:



Peat — Porous pre-coal substance which can hold 20 times its own weight in water and which has a low heating value. Peat occurs very close to ground level as it is very 'young' coal.

Lignite (brown coal) — The least mature form of coal in which the moisture content can exceed 20 percent. Lignite is not particularly efficient in producing energy. Technology exists to liquefy lignite into crude petroleum and to gasify it into natural gas products, but the processes are expensive.

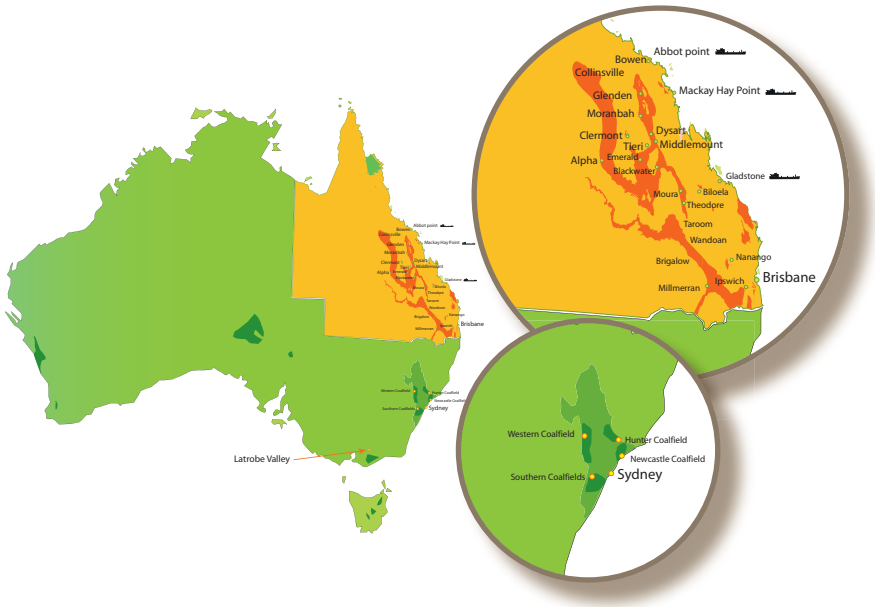
Bituminous Coal — General purpose coal which is black, harder and denser than peat and lignite, and has a relatively high heating value. Types of bituminous coal include PCI (Pulverised Coal Injection), semi-soft, and coking coal.

Anthracite — The highest rank of coal which has a relatively low moisture content and a high heating value. Australia does not produce genuine anthracite coals. However, pseudo-anthracites (heat affected coals) are found.

In summary, as coal matures it becomes harder, drier, shinier, closer to pure black, contains less gas, and has a higher heating value. Naturally, the more mature coals are the most valuable.

2. LOCATION OF AUSTRALIAN COAL FIELDS

The map shows the approximate location of Australia's coal fields. You will notice that Queensland's Bowen Basin has the largest deposit.



In Australia, the main types of coal produced are:

- Hard coking coal and soft coking coal - used in the production of steel.
- Low volatile pulverized coal injection (PCI) coal – used as a supplement that is injected into oil fired power stations to reduce oil usage.
- Thermal Coal – steaming coal used for power generation.

3. MINING THE COAL

Essentially, there are two methods of extracting the coal. These are surface mining and underground mining. Within each of these, there are several techniques by which the coal can be extracted:

- Surface

- strip mining
- open cut mining
- auger mining
- highwall mining

- Underground

- continuous mining (development and bord and pillar)
- longwall mining

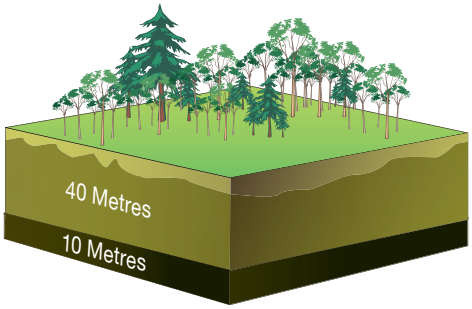
Naturally, the methods chosen are dependant on a number of factors. These include the depth of coal, the thickness and size of the seam, the number of seams, any other geological factors, and the intrinsic safety of the operation. Whatever the case, there is no doubt you will encounter several or all of these mining methods as you pursue your career in the coal industry.

SURFACE MINING

Surface (or open cut) mining is the preferred method of extraction when the coal is at a depth of 60 metres or less.

Economic mining depths can be determined by comparing the volume, in cubic metres, of overburden that must be removed per tonne of coal that is uncovered. This measurement (or comparison) is known as the 'Strip Ratio'. A more easily understood comparison is known as the 'Simple Strip Ratio'.

An example of a 4:1 simple strip ratio can be seen in the adjacent diagram. A strip ratio of 4:1 would be considered very favourable while a ratio of 10:1 would generally be regarded as the economic limit. Naturally, removing greater amounts of overburden relative to the amount of coal reduces the profitability of the operation. If a particular coal deposit is considered suitable for surface mining, two main methods are available: strip mining and open pit mining.



Stripping Topsoil

Firstly the vegetation is removed, and then the topsoil is stripped and stockpiled for use in rehabilitating the mined area. Then the overburden is removed and set aside in spoil piles for replacement once all of the coal is removed. A combination of techniques are used including drilling, blasting, and the use of earthmoving/excavating machinery such as shovels, draglines, and haul trucks.

Naturally, one of the problems that is encountered with open cut mines is drainage. Substantial time and money is spent on dewatering and planning to ensure that the working area of the pit is kept dry.

Blasting

Strip Mining

Strip mining is used to access uniform seams of coal that cover a large area. An elongated trench or 'boxcut' is excavated predominantly using draglines to expose the coal seam. The overburden or 'spoil' from this excavation is put to one side and may be contoured and re-vegetated. The exposed coal is then removed. When the trench has been mined out, it is backfilled with the spoil from the next cut and can then be rehabilitated. Thus, the process of mining and filling continues in cycles until all the available coal is recovered. In this case, the distance that the spoil must be transported is minimised and the rehabilitation of mined out areas is carried out as a part of the mining cycle.

Dragline

Open Pit Mining

Open pit mining is used to access coal deposits that occur as multiple seams on top of each other, seams that occur at different angles, or seams containing multiple fault lines. Open pit mining generally involves the exposure of a large area of coal at one time predominantly using trucks and shovels.

With this type of mining, it is possible to access coal seams at depths of up to 250 metres.

Strip Mining

Auger Mining and Highwall Mining

These are two other types of surface mining which enable otherwise uneconomical coal seams to be accessed.

Auger mining is a process whereby a large mechanical auger (1.5 to 3 metres in diameter) is driven into a coal seam from an existing boxcut or highwall. As the auger is driven into the seam, the coal is forced out on to the floor of the cut. From here, the coal can then be loaded by shovel or loader

onto haul trucks for transportation to the Run Of Mine (ROM) receival or loadout facility as required.

Highwall mining: In this process, a continuous miner enters the coal seam from the highwall of an opencut. Conveyor units are used to feed the coal out to the floor of the cut as it is mined. Once again, the coal can then be loaded onto the haul trucks for onward transportation.

With both auger and highwall mining, no person enters the tunnel created by the auger or the continuous miner and any explosive gases are neutralised by purging with inert gas. The main danger to personnel with these operations is from debris falling from the highwall. For this reason a 'no entry' area is established seven to ten metres from the base of the highwall. The operators of machinery are protected by protective structures built into the equipment.

Open Pit

Auger Mining

UNDERGROUND MINING

Underground mining offers an alternative to surface mining where the coal seams are deeply buried. Most underground coal mines in Australia operate at a depth of between 150 and 300 metres. Modern underground mining makes extensive use of complex machinery which has replaced the wide use of manual labour that was once necessary.

Coal seams can be accessed using a vertical shaft, an inclined drift, or portals at the bottom of highwalls. Vertical shafts are sunk straight down through the rock strata to the coal seam. Drifts are inclined tunnels driven down from the surface until they meet the coal seam. Drift mining is traditionally preferred because conveyor systems can be used to bring the coal directly to the surface. However, the use of highwall portal mines (commonly referred to as punch longwalls) is fast becoming the preferred method because the amount and cost of infrastructure is lower and much of the equipment can be located on the surface. This reduces the need for high cost, flame proof equipment which is required underground.

Punch Longwall

There are two common methods of cutting the coal from the seam or the coal face - continuous mining and longwall mining.

Continuous Miner

Continuous Mining (Development and Bord and Pillar)

In this process, coal is mined by a self-propelled, electrically-powered machine called a 'continuous miner' which uses

powerful rotating picks to cut into the coal face. As the coal is ripped from the face, it is automatically collected by the coal cutting machine and fed onto rubber-tyred transporters called shuttle cars. The shuttle cars then feed the coal onto a conveyor or rail haulage system which takes the coal out of the mine.

Development: This method is commonly used to develop an underground mine. The coal seam is mined using continuous miners to cut a series of tunnels (referred to as travel roads, gate roads or headings, or cut-throughs) to resemble a grid-like pattern. The tunnels into the seam are 'headings' and those crossing them at right angles are called 'cut-throughs'.

Bord and Pillar: The continuous miner is also used to access and extract coal in Bord and Pillar mining. During extraction a series of pillars are formed that support the rock above. When the pillars are later removed, the mine roof is allowed to collapse, filling in the space left by the removed coal. During the mining operation, timber and steel supports are used to control the strata.

Longwall Mining

The main method of underground coal extraction is longwall mining. The process involves mining large blocks of coal which are created by cutting headings into the coal seam between 100 and 400 metres apart. A third tunnel is driven between the two headings to create the longwall face. It is from this point that the longwall shearer begins cutting the coal.

Shearer

The coal is extracted completely using a shearer which consists of forward and rearward revolving drums that remove coal as they move across the face. This leaves the area mined out, with the roof collapsing behind the longwall equipment. As the coal is removed from the face, it falls onto a chain conveyor that transports it to a crusher and onto a conveyor system to the surface. Roof support over the face area is provided by a series of hydraulic powered chocks which are individually controlled, and which move in sequence as the face moves forward. As the chocks are moved forward, the roof area behind collapses into the goaf.

4. PROCESSING COAL

Most coal mines are supported by a processing plant. The purpose of a processing plant is to clean the coal by removing unwanted impurities and to categorise or classify the coal into its various grades. This is an important step in the process of coal production because it enables consistent standards to be maintained which means better market acceptance and greater profitability.

During processing, Run of Mine (ROM) coal is taken directly from the mine and fed into the processing plant via a ROM receival facility. From here, the coal will be put through a series of processes that may include:

- crushers
- flotation units
- cyclones
- sieves
- screens
- centrifuges
- thickeners
- filters.

Processing Plant

This machinery crushes the coal, separates unwanted refuse and rock, classifies it, and dries the coal. As part of the classification process, the coal will be designated as either steaming or coking coal. This is done by taking small samples of the coal and subjecting it to heat tests. As a result of the tests, a crucible swelling number (CSN) is given to the coal which indicates its ability to be used as coking coal.

Coking coal has the ability to fuse into a molten mass when heated and then harden to form coke. Coking coal normally has a CSN of above 5 on a scale of 0 to 9. Coals that fall below the CSN 5 can be used in pulverised fuel applications.

Generally speaking, coking coal is used in the metallurgical industry in the production of steel while steaming coal is most often used in power generation. Once the coals have been processed and classified, they are stockpiled ready for blending into different mixtures according to what the customer wants, and transported to their final destination.

5. MARKETING COAL

If the mining and processing sections of the enterprise have been functioning correctly, the coal should be produced in a condition that is ready for marketing. Each individual worker has the responsibility to perform their work in such a way that the quality standards of the coal are met.

Coal is a valuable source of energy and as such it is one of Australia's largest export earners. Essentially, it is used in power stations in the production of electricity or in steel works in the production of steel. Most frequently, coal for export or for use in steel production has been through the processing plant. Often, coal that is to be used in Australian power stations is supplied in its raw state.

SUMMARY

This topic has provided a brief description of the coal industry and coal mining. You should now have the big picture of the industry that you are about to enter.