# Coal Mining - basics

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## Coal Mining Methods

- Underground
  - Bord & Pillar
  - Longwall
- Surface
  - Open Cut Strip
  - Open Pit
- Highwall
  - Auger
  - Continuous Highwall Miner
  - Punch

## Bord & Pillar

- Continuous Miner & shuttle cars or continuous haulage
- Highly flexible, high cost – can handle geological variability
- 1.5-3m per pass, but can take up to 3 passes in good conditions
- Preferably less than 10° dip and less than 500m depth of cover
- Multiple units possible to vary coal source and increase production
- Best with good floor and roof plus strong coal
- Working section may include roof and floor but coal may be left on roof or floor to improve conditions
- Single seam – reasonably constant production
- Pillar extraction to improve coal recovery to a maximum of around 65%

## Continuous Miner

## Longwall

- Specialised equipment consisting of hydraulic face supports, shearer, chain conveyor, sizer, etc
- Inflexible technique requiring a block of 200-400m wide by 2-4km long for a single face
- High capital requirement, but can be low operating cost
- Standard longwall has a face height of 1.5-4.5m with a dip preferably less than 10º and less than 1000m depth of cover
- Can mine through small faults and dykes with increased dilution, and can mine thicker seams using top coal caving at the expense of up to 20% dilution
- Large production peak generally greater than 3 times average
- One month delay during face relocation
- Usually single longwall coal source plus development units
- Coal recovery up to 85%

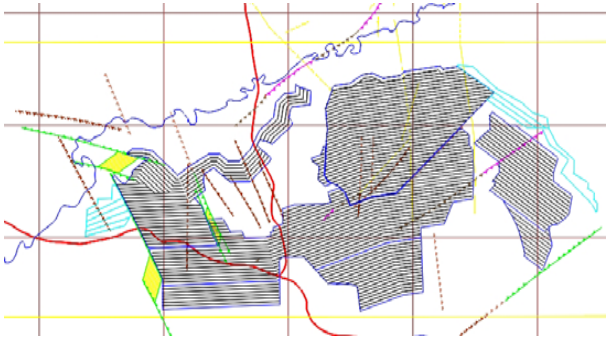
## Longwall Face

## Unplanned Longwall Delay

## Open Cut Strip

- Flat lying with less than 10º dip and a single or multi-seam deposit
- Long narrow strips less than 100m wide and 2-15km long with a maximum pit depth less than 200m
- Dragline and/or shovel/truck stripping of blasted overburden, possibly assisted by production dozing
- Coal mining by front end loader or excavator into trucks
- Coal mining rate relatively uniform but subject to surges due to availability of exposed coal
- Mining exposed coal gives supply from a single source for an extended period. Blending from multiple seams/areas is possible
- Dilution is from weak floor & cleanup due to waste not separating from coal and coal contact irregularities. Increases with poor drainage & blast damage. May also include weathered, spon. com. or contaminated U/G coal.

## Open Cut Strip Layout



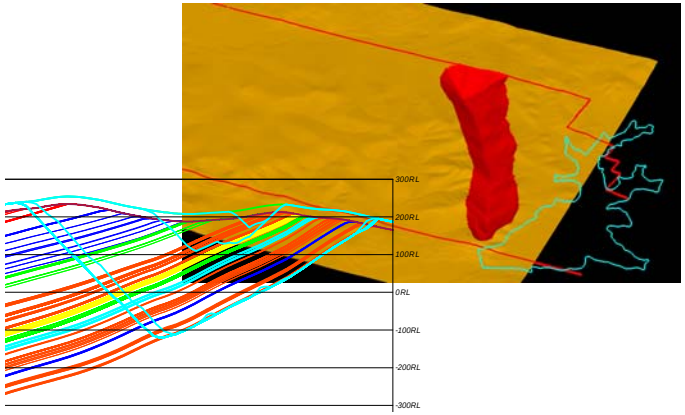
## Dragline Strip Mining

## Coal Hot Out of the Open Cut

## Open Pit

- Any dip:
  - Shallow dip with benches on seams
  - Steep dip with benches on horizontal levels
- Smaller pit dimensions, generally multi-seam with greater than 30% of waste hauled out of pit. Mining progresses in large cut-backs or panels
- Varies from small, shallow operations to large capacity mines up to 400m deep
- Shovel or excavator & truck waste removal
- Excavator or front end loader coal mining with rear dump truck haulage
- Multiple coal sources available from a number of seams giving a uniform production rate
- Dilution from similar sources to open cut, but may be greater with steep dips due to through seam blasting
- Coal recovery generally greater than 90%

## Layout and Section of Steep Dip Open Pit




## Open pit with spontaneous combustion

## Augering

- 1.35-1.8m dia. auger or a 1.5m dia. twin auger
- Reliably excavate to 160-200m from the open cut highwall
- Can multi-pass in thicker seams
- Recovery 30-60% with limited dilution
- Relatively unaffected by weak strata
- Approximately 0.5Mtpa

## Single & Twin Augers




## Continuous Highwall Miner

- 1.5-3m extraction height from a rectangular heading using a continuous miner and highwall miner continuous haulage
- Reliably excavate to 350-500m from the highwall
- Can double pass in thicker seams leaving a septum
- Recovery 45-60% with dilution similar to underground mining
- Must have strong strata
- Approximately 1.0Mtpa

## Punch Mining

- Longwall or bord and pillar mining with panel access directly from an open cut highwall
- Similar mining conditions and constraints to underground mining by these techniques

## Mine Planning & Technical Services

- Pit design to maximise economic recoverable coal (NPV?, meet product specifications, maximise production)
- Scheduling to keep primary stripping equipment busy and meet production targeted quantity & quality
- Mining method and geology provide iterative economic relationship
- Provide communication, coordination and monitoring from pit to market (survey, geology, coal quality)
- Other issues
  - Water management
  - Geological and geotechnical problems
  - Environmental control and rehabilitation
  - Blasting design and monitoring
  - Production monitoring
  - Hauls and Dump location
  - Medium & long term planning

## Production

- Moving overburden is main focus in most surface mining operations
- Majority of equipment is used on overburden removal
- Coal mining is a minor cost item but can have a major impact on profitability
- Weather and underground drainage is important
  - Rain affects blasting
  - Water disrupts coal ripping, blasting and mining

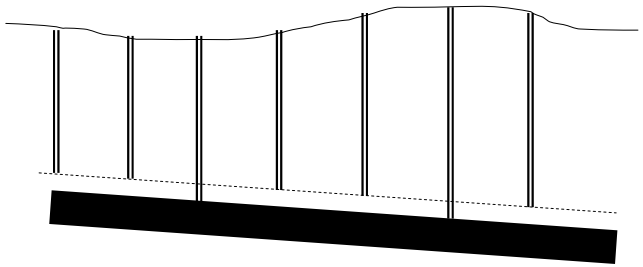
## Drill & Blasting

- Why blast
  - To break up overburden for digging
  - Alternatives ripping and surface miners
- Issues
  - Environmental (overpressure and vibration)
  - Damage to coal roof and edge
  - Good blasting vital for productivity

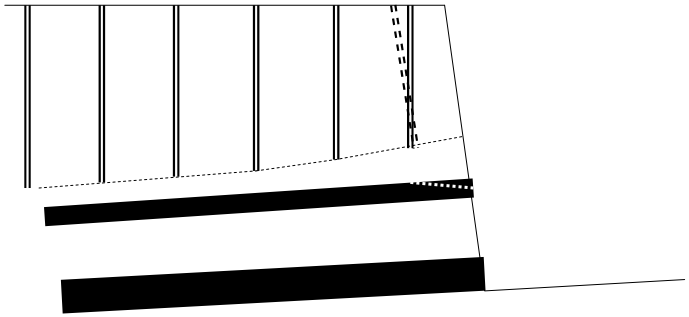
## Drilling & Blasting

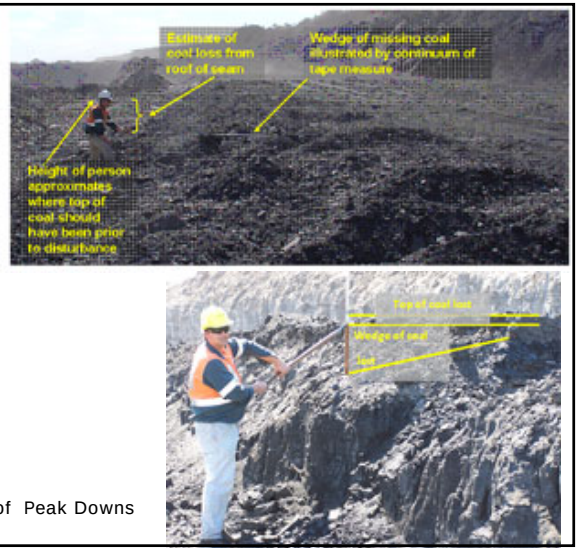
- How to control blast damage
  - Correct depth for holes
    - Set standoff based on material type
    - Touch drilling
    - Increase standoff at edges
  - Charge and initiation sequence

## Check true depths



## Edge damage






By Courtesy of Peak Downs

## Dragline

- Advantages
  - Low cost per bcm moved
  - High productivity
  - Can coal close to face
- Disadvantages
  - High capital cost
  - Requires good conditions, less flexible
  - Depth of mining limited
  - Blending from pit more difficult
  - Cable handling and power demand


## Shovels

- Advantages
  - More flexible than draglines
  - Can be very productive in right conditions
    - Need wide faces, good blasting, flat floors
- Disadvantages
  - Cost per bcm higher than dragline
  - Associated equipment (trucks, dozers, graders, road maint)
  - Several passes may be needed hence coal not available
  - Cable handling

## Hydraulic Excavators

- Advantages
  - More flexible than shovels
  - Lower capital cost
  - Can be very productive in right conditions
  - Good coaling tool
- Disadvantages
  - Cost per bcm higher than shovels (but not by much)
  - Associated equipment (trucks, dozers, graders, road maint)
  - Dig depth limited (5m under) - several passes may be needed hence coal not available
  - Shorter lifespan

## Front end loaders

- Advantages
  - Most flexible machine (though needs good floor)
  - Most mobile
- Disadvantages
  - Cost per bcm higher than shovels/excavators
  - Associated equipment (trucks, dozers, graders, road maint)
  - Dig depth limited - several passes may be needed hence coal not available
  - Water control on floor

## Coal Preparation - mining

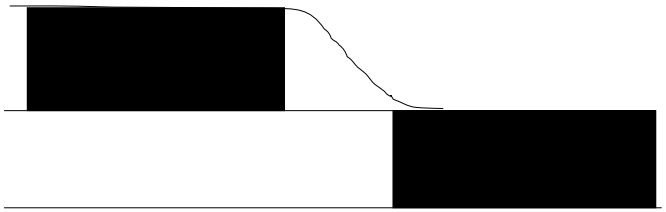
- Clean roof
  - Dozer to push roof material
  - Does parting stick to roof
  - How variable is the seam contact
  - What is clean – how dirty is the top coal
  - Aim to minimise roof losses and dilution
  - Rubber tyred equipment gives lower loss
  - Grader cleanup can improve coal recovery

## Coal Preparation - mining

- Rip coal
  - Dozer to rip for loader
  - Depth limited by ripper tyne, hardness
  - Rip and push generates fines
  - What ripping spacing, is cross ripping needed
  - Fines generation can be reduced by optimum ripping

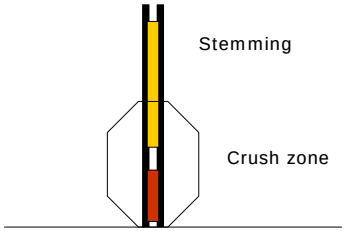
## Thick seam - rip and push

Two passes if coal quality different
Single pass if blending needed



## Coal Preparation - mining

- Blast coal
  - Seam must be thick enough (3m?)
  - Stemming material in hole
  - Plastic nonel blast lines in coal
  - Crush zone around each hole




## Coal Preparation - mining

- Clean floor and edges
  - Dozer to push floor coal and along highwall
  - Does coal stick to floor
  - What is clean
  - Aim to maximise coal recovery but minimise dilution
  - What coal should be mined – bypass vs. wash – selection of working section
  - Soft floor and poor drainage give higher dilution
  - Throw blast can place coal toe under spoil and increase edge dilution

## Selective mining

- To recover high value intervals
  - Eg recover a SS Coking coal section out of a thicker seam
  - Normally slows production
  - Leaves higher ash product
  - Total value added must be determined
- New machines being introduced to eliminate blasting can also be selective

## Surface miner

# Summary

- Mining is a compromise between:
  - maximum productivity
  - minimum cost/t
  - coal recovery vital over long term
- Underground & highwall mining characteristics:
  - Single coal type with potentially high dilution
  - Mines a working section based partly on geotechnical considerations
  - Very high peak production
  - All coal is cut by pick with high fines content
  - No selective mining possible – limited range of cutting heights
- Surface mining characteristics:
  - Multiple coal sources with dilution dependant on seam thickness and mining conditions
  - Working sections based on economics and practicality
  - Uniform production rate
  - Coal may be ripped, pushed, blasted or dug unshot with varying fines generation
  - Selective mining possible to provide feed for different products or blends
  - Mining from multiple sources can assist in overcoming problems (blinding screens, excessive rejects or slimes) but can also result in surging due to cyclical loading