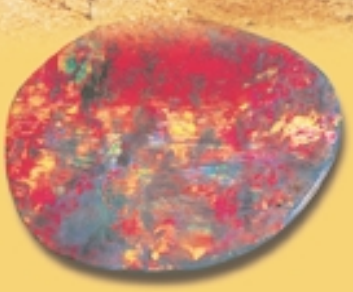
Safety in *Opal Mining*

Opal Miner's Guide

Mining & Quarrying
OCCUPATIONAL HEALTH &
SAFETY COMMITTEE



South Australia Opal Fields

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Awards recognition

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Awarded to Safety in Opal Mining Project.

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Black Opals
Majestic Opals

Safety in Opal Mining

Opal miner's guide

A South Australian Project.

Funded by: The Mining and Quarrying Occupational Health and Safety Committee.

Project Officer: Sophia Provatidis.

With input from the miners of Coober Pedy, Mintabie, Andamooka and Lambina.

Contents

Opal mining has been described in the past as a pioneer industry where danger and fatalities have been thought of as "facts of life". In our modern society such a view is no longer relevant or acceptable. As with any dangerous industry, good occupational health and safety practices are essential for a safe and productive work environment.

The Mining and Quarrying Occupational Health and Safety Committee (MAQOHSC), a Committee which reports to me, saw the need for good quality occupational health and safety information for opal miners.

Most miners are self employed and lack the corporate support that often makes occupational health and safety a reality. MAQOHSC provided funding for the production of this guidebook and companion video to meet a vital information need.

Sophia Provatidis, with her knowledge and experience of the opal mining industry, was engaged to conduct the project. The Safety in Opal Mining Committee, with miners from various organisations and groups, was formed to guide the project. Its brief was to ensure the information products were down to earth and relevant. The energy and enthusiasm of the Committee for the opal mining industry and for their fellow miners has ensured a successful outcome.

The guidebook and companion video promote a 'Work to Live' environment in the opal mining industry and will lead to fewer incidents and fatalities. As the Minister with responsibility for Workplace Safety this is an objective I strongly support. I commend MAQOHSC, Sophia and the Safety in Opal Mining Committee for their efforts in raising the awareness of the opal mining industry to occupational health and safety.

Michael Armitage

The Hon Dr. Michael Armitage
Minister for Government Enterprises

Forward

The safety in opal mining project is the first of its kind in South Australia. The project was made possible with the support and funding of the Mining and Quarrying Occupational Health and Safety Committee. The opal mining community of South Australia sincerely thanks them.

Since opal mining began in the early 1900's the hazards facing the industry were not controlled or managed in any way. This resulted in many incidents and fatalities. In general most miners are self-employed. Their independent and pioneering spirit failed to support an active approach to protect themselves or others against hazards.

As I have worked in the opal mining industry for more than three decades, I could see the need for this booklet and accompanying video to raise Occupational Health and Safety (OHS) awareness in the opal mining industry. The involvement of the whole community, especially the opal miners, can be seen by their willingness to be interviewed and featured in the video. The miners are looking forward to receiving the OHS video and guidebook for promotion within their local networks. I believe everyone who participated are proud to be associated with the outcome - an opportunity to promote safety in the opal mining industry.

The information that will be distributed to the South Australian opal industry is expected to make a significant impact. This is the first time that such information is freely available and in easy to understand format. There is also a view that the information would be updated as the industry start to discover better safety measures or develop initiatives through collaborative research with safety experts.

I would like to acknowledge the "Safety in Opal mining Committee" for their great effort, also the many mines who have not only contributed to the project, but in the end have championed it.

Sophia Provatidis

Acknowledgement

- Mining and Quarrying Occupational Health and Safety Committee (MAQOHSC).
- Safety in Opal Mining Committee.
- All the miners who contributed.
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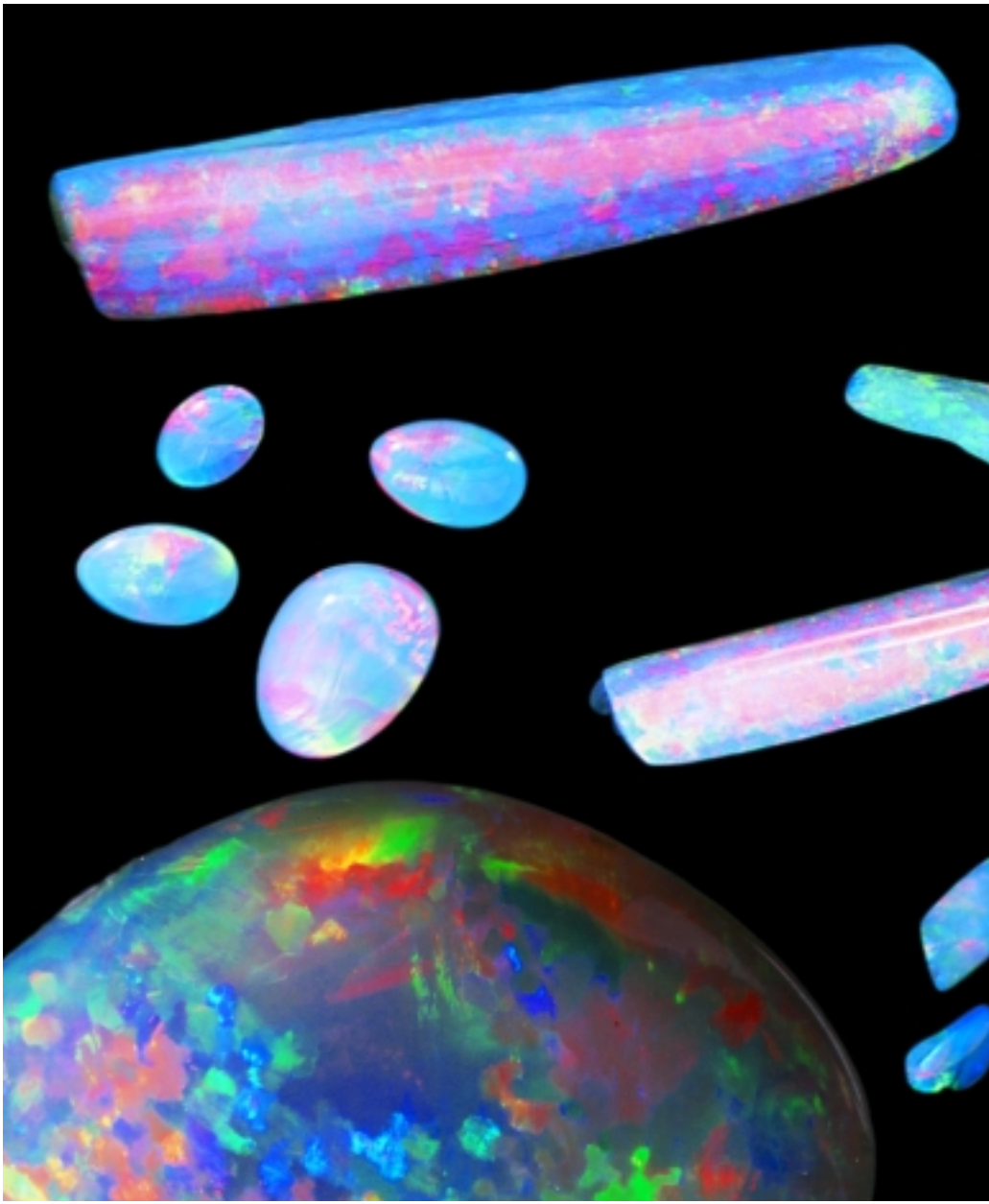

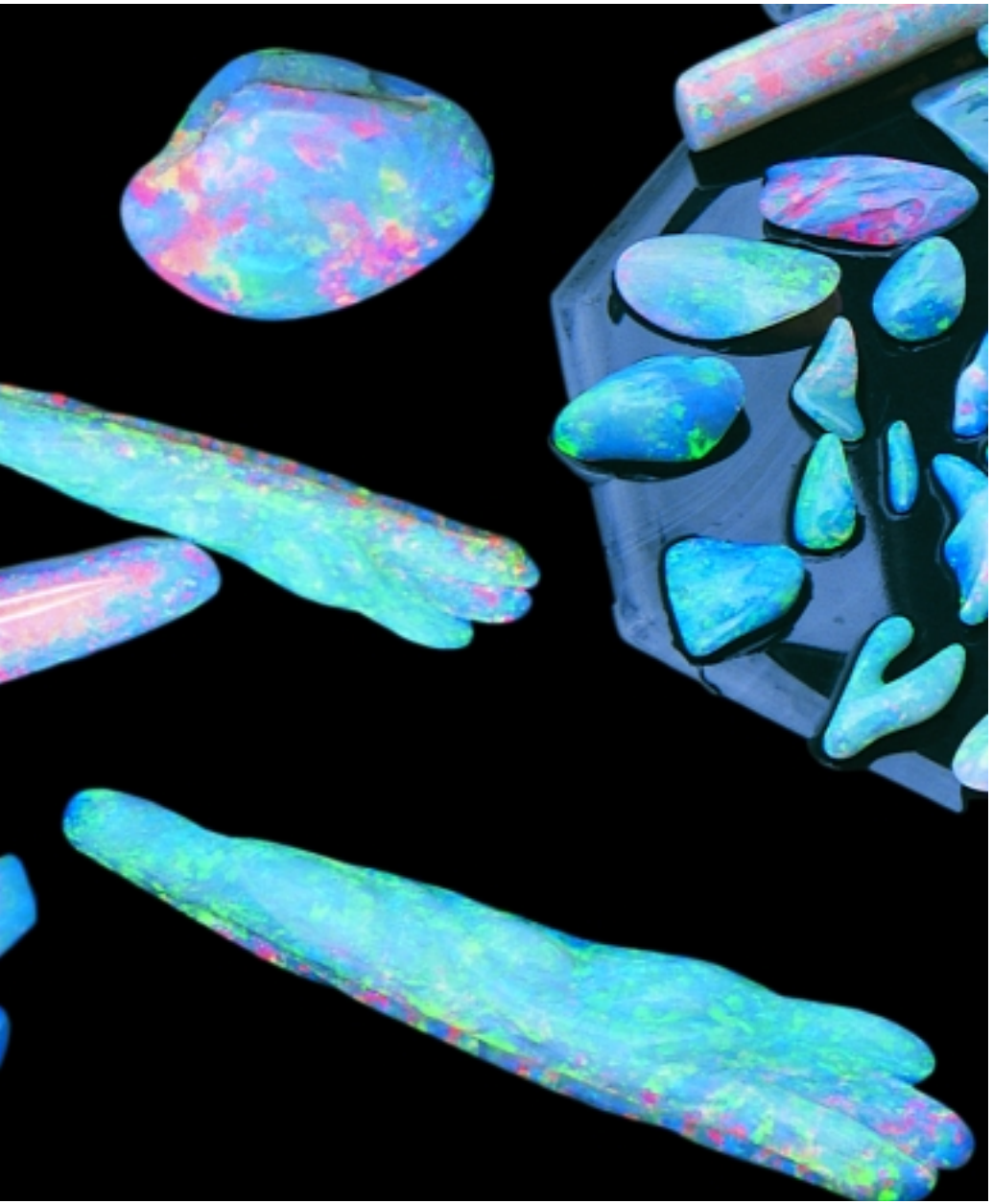

Opals by: Majestic Opals.

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Introduction

Opal mining is an exciting but potentially hazardous occupation. Only experienced miners really know how hazardous it can be. The responsible opal miner should know how to minimise risks arising from those hazards and make them acceptable. Inexperienced miners should gain experience first by working with an experienced miner.

Short cuts and cost cutting increase the risk of the opal miner being seriously injured or killed.

The concept behind this booklet is to make miners aware of the risks they are facing as they carry out their everyday tasks and to put forward some suggestions that have proven successful elsewhere.

The definitive answers are not here. Only a miner working in a particular mine can know what the safe answer may be in any particular situation. The aim of this booklet is therefore to help the miner make appropriate decisions.

It is extremely important to make sure that everything is in the best condition possible, not only for the miner, but also for the safety of others. Noodlers, other miners and tourists, all may come onto a claim, either while the miners are working there, or long after they have pulled pegs and gone. What has been done in the past and the condition in which a mine is left, could have a major impact on the safety of those people.

There are certain laws and regulations set by the government that must be followed. This booklet strongly supports complying with those laws and in fact recommends them as the minimum standard that should be followed.

Appendix B in this booklet highlights some of the most important of those regulations.

Major Hazards

Following a review of accident statistics and a survey of South Australian opal miners and their representative bodies, a meeting of an industry committee on 4 May 1999 defined table 1 (page 11) as being the most significant hazards faced by the opal mining industry.

An open industry meeting was held in Coober Pedy, attended by 40 miners and major stakeholders of the opal mining industry. It was confirmed that these are the hazards of most concern.

These are not the only hazards faced by people working in the industry, but they are seen as being those with the most significant impact. Miners are exposed to these hazards most frequently and the consequences are seen as the most severe. A review of some of the most significant issues with these hazards follows.

Table 1

1. EXPLOSIVES
2. UNSTABLE GROUND
3. SHAFTS
4. MACHINERY
5. DUST

Preparing the Claim

Introduction

Whether the area is new or has been previously worked, it is important to fully check for any risks. There could be small drill holes, backfilled or covered shafts that are not immediately obvious because of re-growth. Mark anything that could present a hazard. Clear the area of vegetation and make a flat section around your main working area.

Make a note of all backfilled shafts on the surface and calculate their approximate position underground so that you will be aware of them when mining nearby. Back filled shafts can colllapse into workings below.

It is advisable to give them a wide clearance. If you are mining old workings, make sure you ventilate them.

Make sure you know where your boundaries are. If your claim is close to a road, make sure that you will not be mining under the road. You may need to sink your shaft on the road side and work back into the claim.

Make sure you are aware of where your neighbour's boundaries are to avoid breaking into their mine. Breaking through into the side of another drive may result in a significant cave-in.

If you are going into a previously worked area check all drives, pillars and levels for poor ground and map out the existing workings, noting the dangerous areas you find. Unsafe things to look for include:

- workings on two levels with the lower level directly beneath the upper
- large un-pillared areas (called ballrooms) or pillars which are not on top of each other.
- thin crown pillars between the two levels. This is likely to occur where the top level is running downwards slightly or the bottom level is running up. The previous miners may have not even noticed what was happening.
- Fretting pillars or cracking pillars and cracks in the wall or roof
- The size of the pillars too small to support the roof.

Refer to appendix A for ground support information.

If you are in doubt, get an experienced person to check it for you.

Checklist - Preparing the Claim

1. Clear the area.
2. Check the area and mark all hazards including abandoned shafts.
3. Confirm your boundaries and your neighbour's boundaries.
4. In previously worked areas, assess for poor ground and structural hazards.

Explosives

Introduction

Experience in using and handling explosives can often lead to complacency. It is important to remember that mishandling a detonator can result in the loss of a finger or two. Mishandling anything bigger can result in much more severe consequences.

Licences

There are licences required for the purchase, transport, storage and use of explosives. See your local PIRSA office for details.

Storage

Explosives must be stored in a cool, dry place and detonators must be stored separately from all other explosive materials. All explosives are to be stored in a proper box with a secure lid which can be locked. Boxes should be wood lined and labelled with their contents (explosives or detonators), and stored in a separate shed. Keep it locked when you are not around and of course, make sure that the kids can't get to any explosives.

The Nitropril and deisel should be stored so that they will not mix in the case of spillage.

Keep all steel objects or any other thing that could create a spark at least seven metres away from the explosives.

It is illegal to store more than three kilograms of explosives or 100 detonators unless you have a licence. Explosives must not be stored in a dwelling or any part attached to the dwelling.

Transport

When transporting explosives, the vehicle must have the required signs. (The word EXPLOSIVES in red letters, 125 mm high on a white background, visible from front and rear) The vehicle should not have any other flammable material on board when carrying explosives and a fire extinguisher must be on the vehicle. Keep the detonators away from other explosives.

It is illegal to transport more than 3kg of explosives unless the vehicle is licensed to carry explosives(see your PIRSA office).

Preparation

ANFO (Ammonium Nitrate Fuel Oil) is the most commonly used explosive on the fields.

Mixing Nitropril with diesel (16 parts nitropril to 1 part diesel) makes ANFO. The usual size mix is 1.9 litres of diesel to a 25kg bag of nitropril.

The use of anything other than diesel is not only illegal but also hazardous. This is because if the product used gives off a vapour, that vapour can be ignited while lighting the fuse. This could result in an explosion, not giving the miner the normal fuse-burn-rate time to exit the blast area. For this reason, petrol, kerosene or any liquid with a flashpoint lower than 61 degrees celsius must not be mixed with the Nitropril.

Never pour ANFO out of a plastic container into a paper 'sausage' as the friction can result in the build up of static electricity. Cardboard or paper funnels and cups should be used.

Do not use plastic as it generates static electricity.

Static electricity is one of the most significant hazards when handling explosives. Whenever equipment such as a mixer is used, an earthing stake must run from the machine to the ground to give the static charge an easy path to ground without creating a spark. Mechanical mixers need to be approved by the Chief Inspector, DAIS.

Keep steel objects, or anything that could cause a spark, away from explosives. Use only timber, or other non-sparking tools with explosives. Detonator cord should be cut with anvil action secateurs, or a sharp, single bladed tool (knife or razor blade) on a wooden block. Detonators should only be attached using a proper crimping tool and a detonator must be taped properly to the detonating cord.

Blasting

The area to be blasted should be properly prepared. (Loose material that could become fly rock should be removed).

An adequate size and number of holes should be drilled for the amount of material to be removed. If using stemming, fill the holes to the top.

The length of time your fuse gives you to exit the blast area may save your life. Fuse burning speed should always be checked on each new roll of fuse and before manufacturing the charges for each blast. In general, this fuse normally burns at 100 seconds per metre when new and in good condition. Fuses should be a minimum of one metre long but this depends on the number of charges you are lighting. Up to eight fuses, the recommended length is one metre. More than eight charges requires two metres.

Do a final check to ensure that your winch motor is running, the winch is working properly and that you have plenty of time to get up the shaft and on to the surface, before lighting your fuse(s). Use a warning and checking system to ensure all other people are clear of blast area.

Use a fuse lighter to light the fuse. Carefully count the blast, to make sure all charges have gone off. Following the blast do not re-enter the mine for thirty minutes in case of a misfire or slow burning charge.

Check for misfires and make misfires safe or re-fire.

Explosive fumes

Blasting generates carbon monoxide, nitrogen oxides and various other gases, dependant upon the amount and type of explosives used and the make up of the ground being blasted. Fumes contaminate and displace the oxygen available for breathing. Consequently it is vitally important to make sure your mine is well ventilated before going back down after a blast.

It is strongly recommended that miners do not stay underground during the blast because of the fumes that may be produced and the fact that sections of the roof may fall as a result of the blast.

Because most underground mines have at least two or three openings there may be a natural airflow through the mine. The direction of this flow can change from day to day and even during the day. Consequently there may be sections of your mine where 'dead spots' (no airflow) can occur at one time and then later there will be air flowing through the area. These areas particularly need to be checked after a blast as fumes may have collected there.

Carbon Monoxide is lighter than air and can collect up in roof cavities and high spots in the mine. Carbon Dioxide is heavier than air and can collect in floor cavities and low spots in the mine.

Relying on natural ventilation is the least preferable option. Fans, blowers and other ventilation systems should be switched off prior to the blast, but they should be switched on immediately after to remove the fumes. The use of your blower pipes is the best option when ventilating an

underground mine after a blast. Mechanical ventilation is often better, faster and more reliable than waiting for natural ventilation to work, as this could take up to several days for a mine with a single shaft.If natural ventilation is used it can often be easily and cheaply improved by the use of a wind sock.

The South Australian Department of Administrative and Information Services released the third edition of an excellent booklet called 'Explosives Safety in the Opal Fields' in October 1998. Following the guidelines in this booklet will ensure that the miner is as safe as can be while using these hazardous materials.

Checklist - Explosives

Storage

1. It is illegal to store more than 3kg of explosives or 100 detonators unless you have a licence.
2. Explosives must be stored in a cool, dry place.
3. Detonators must be stored separately from all other explosive materials.
4. If reasonably close to each other, the Nitropril should be stored in a higher spot than the diesel, so that if there is a spillage it will not run down and mix.
5. Keep all steel objects or any other thing that could create a spark at least 7m away from the explosives.
6. All explosives are to be stored in a proper wood lined box with a secure, lockable lid. Boxes should be labelled with their contents. (explosives or detonators).
7. They must be stored in a lockable shed which is not a dwelling.

Transport

1. It is illegal to transport more than 3kg of explosives or 100 detonators unless the vehicle is licensed to carry explosives.
2. The vehicle must have the required identification signs for transporting explosives.

3. A fire extinguisher must be on the vehicle.
4. The vehicle should not have any other flammable material on board when carrying explosives.
5. Keep the detonators away from other explosives, in or on the vehicle.
6. A vehicle carrying explosives should not be left unattended

Preparing explosives

1. Prevent the generation of static electricity.
2. Do not use plastics or create friction.
3. Everything must be properly earthed.
4. Mix in the right quantities (16 parts Nitropril to 1 part diesel).
5. Check the burning speed of fuse (approximately 90 - 120 seconds per metre).
6. Allow adequate length of fuse. (Recommended minimum 2metres).
7. Ensure good contact with earth when fitting detonators to the fuse.
8. Detonators must be clean inside where the fuse is inserted.

9. Detonators must be properly crimped to the fuse using the correct crimping tool.
10. A detonator must be taped properly to the detonating cord.

Blasting

1. Make sure there is a clear exit from blast area.
2. If staying underground during the blast, make sure the ventilation is adequate.
3. If staying underground during the blast, have an appropriate safe haven.
4. If staying underground during the blast, ensure there is a good means of escape if anything goes wrong.

After the blast

1. Make sure underground areas are properly ventilated and safe to enter.
2. Check for misfires.
3. Make misfires safe or re-fired.
4. Scrape down roof and high sections of walls using the correct tool for the job.

Unstable Ground

Introduction

The opal fields have a range of geological structures. Some of these will support reasonably wide underground openings, others are of a small blocky material with many faults in which it would be unwise to attempt any sort of underground mining.

As detailed in *Opal - South Australia's Gemstone - SA Department of Mines and Energy 1992*, "A feature of South Australian opal bearing rock is that it is weathered, brittle and fractured". Consequently special care needs to be taken when working in it.

The ground is different in each of the opal mining areas - Andamooka, Coober Pedy, Mintabie and Lambina. Within each area the ground also differs. Differences are due to different stress distributions and rock types.

It is the miner's responsibility to decide whether they should, or should not be underground mining in a particular area. If you are not sure, ask an experienced miner.

Cave in

When commencing any underground mining it is important to survey your claim and note the existence of any past mining work. Mining under a backfilled shaft or into old workings can result in the miner being buried and seriously or even fatally injured.

Opening a drive too wide can result in the roof caving in. Miners need to be constantly aware of the condition of the roof and the stability of the material above. Hidden faults in the roof will result in rockfalls. This has killed miners in the past.

If driving underground from an open cut the entry should be kept as small as possible. The outside ground above the entry should by free from weathering, loose rocks or overhangs which may give way and fall.

When mining below a previously worked level, care should be taken to ensure that pillars line up with those above. Extra pillars may be needed in the lower level. Obviously it is safer to work the lower level first. If opening up from a lower level to include a higher level into one large opening, thoroughly inspect the ground, particularly looking to support the ground above where it may not be safe. Signs of unsafe ground include faults, slippery backs, blocky ground, opening cracks and 'flaking' roofs.

The roof should be properly scraped down if the surface appears to be flaking and after blasting. A proper scaling bar (approximately 2.0m long) should be used as this allows the miner to keep well away from where the material may fall. Picks should not be used as the material could fall onto the miner. Walls may become flaky, particularly as they dry out and this can cause them to fall out into the drive. They should be scraped down as needed.

Correct technique

Incorrect technique

Air entering the mine may dry out the ground and open up natural cracks, slides or faults in the ground around the base of the shaft. A number of serious accidents have occurred when slabs have fallen from around shafts that have been undermined. To help ensure this does not happen, leave a pillar next to the shaft.

When mining close to the water table (in particular at Mintabie) or where heavy rain has resulted in a significant amount of water getting into the mine, special care needs to be taken as the water may have significantly reduced the supporting strength of walls and pillars. You should particularly look for 'fretting' away at the base of the supporting structures.

'Pillar bashing' is not an advisable practice. There is a good reason to leave a pillar where it is. If the ground looks unstable in an area containing opal, use a few props to support the roof. Metal jacking props with timber packing may serve the purpose for a short time and these can be removed when you leave the area. In the NSW opal mining industry, timber props and roof bolts are commonly used.

Falling Objects

Where a shaft is being used, the rim should be kept in good condition and free of loose material, rocks and tools which could easily be dislodged and knocked into the shaft. Wherever possible, do not stand at the bottom of a shaft in case anything does fall down.

When opening a drive off the bottom of an open cut there is a risk of being hit by rocks falling from the face above, especially just after the first blast. The face above should be closely inspected after the first blast and scraped down before starting the drive.

It is better to drive in under a wall that has been battered back or benched. This will minimise the risk of being hit by falling objects.

Be aware that open cut walls can fall if they are not stable. Before opening a drive, note the direction and angle of bedding planes and make sure that you are not driving under an overhang, ground showing signs of bad weathering, or an area which has been undercut.

Wear a hard hat at all times when working in a cut because if someone else is working above, they could dislodge loose material, or if they are doing maintenance work on a machine, they could drop something over the edge. Wind, weathering or even a blast on the next claim can also cause loose material to fall out of a wall. Never work directly above someone working in a pit.

Fallen Undercut

Badly weathered ground above 2 old drives

Changing Ground

As you start to open a drive off the bottom of a cut, watch for changing ground conditions. This is where you may get your first real indication of what the ground is going to be like as you go further underground. Look for indications of slips, or the ground above becoming more 'blocky'.

When opening a drive under a face that has been battered back, ensure that the thickness of the material above will provide enough support for the entry to stand up.

You will need to check the ground at the bottom of the shaft when starting to open up a drive. Check the walls of the shaft all the way down for signs of anything that may become dislodged once the shaft becomes regularly used. Make sure that anything that looks as though it could work loose is cleaned out. While doing this look for any signs in the ground that may indicate instability.

After the first blast, closely inspect the material to be driven through for any signs of faults that may cause the roof to fall. Consider how wide the drive should be and whether the ground can support an open span at that width.

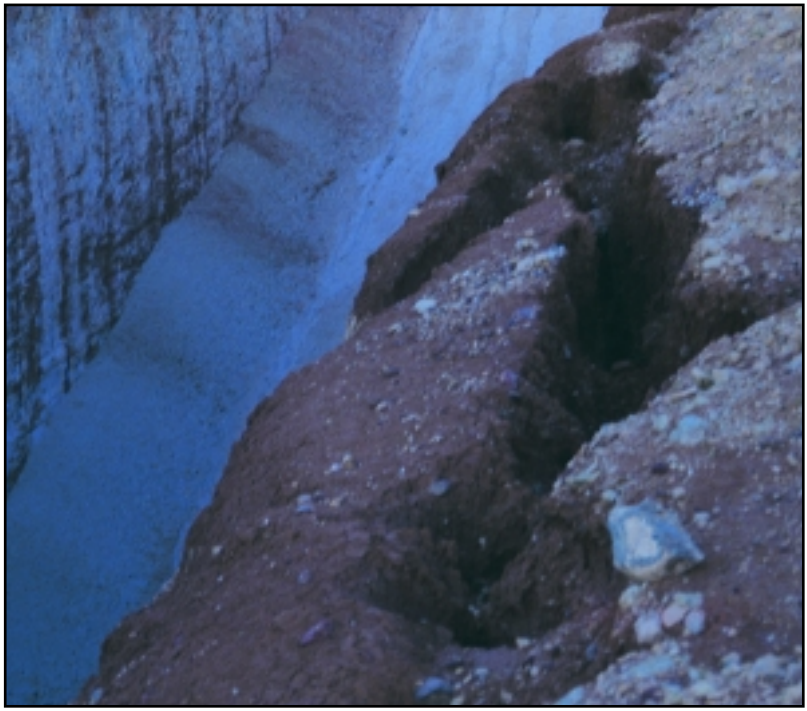
An inexperienced miner should get a more experienced miner to come and give advice on this. Never be too proud to ask questions about the strength of the roof above your head. Cave-ins have killed the highest number of people on the opal fields.

Changes in the strength of ground can happen quickly and with little warning. You need to know what you are looking for **and** you actually need to look.

After a while in the fields, miners often become complacent and do not check the stability and strength of their underground roof and walls as often as they should. It is recommended that these be checked **daily** before the start of work.

Checklist - Unstable Ground

1. If driving underground from an open cut the entry should be fully supported and kept as small as possible.
2. The outside ground above the entry should by free from weathering, loose rocks or material or overhangs which may give way and fall.
3. Check that the face is secure and free of overhangs.
4. Check that the ground is sound and supportive.
5. Bar down the roof and walls to remove any material that may become loose and fall.
6. Check regularly for changes in ground conditions.
7. Check for back filled shafts overhead.
8. Check that pillars line up vertically when mining two levels.
9. Check for the proximity of any areas that have been previously worked.
10. Check that all areas except the working face are free from fallen material or things that could cause a tripping hazard.
11. Make sure there is clear access to the shaft or exit in the case of an emergency.



Badly weathered ground

Shafts

Introduction

Shafts are generally cut with a Calweld drill and are about one metre in diameter. Occasionally they are reamed out to approximately two metres in diameter. Investigator drill holes approximately 250mm diameter also exist in numerous places across the fields.

General Safety

Always ventilate blind or dead shafts before entry to clear away gases.

Keep support structures at the top of the shaft (timbers, pipes, tripods etc) in good condition and on strong, firm supporting material.

Keep all services (electrical supply, winch ropes, safety ropes, blower pipes, ventilation bags) free from the risk of damage by things travelling up or down the shaft.

If the shaft has been hand mined, clean up of the walls will require more work. The walls should be kept even. It is important not to undercut the rim as this could collapse later, either through general weathering or because of the weight of the planks and other equipment, or people.

Install and maintain adequate lighting.

Entry and Exit

All underground workings must have at least two means of exit. It is most common to have a fixed or wire rope ladder in at least one shaft providing access to underground workings. This provides an escape route should the winch fail for any reason.

Some miners still use only a rope, but in an emergency you need to leave in a hurry, so this is the least preferable of the options.

Many shafts have loose rocks and are unsafe to travel in. Some shafts can be made safe by various means (eg lining the walls, removing the rocks.) A cage with a canopy may be used.

Ladders that are permanently fixed in shafts are subject to weathering and corrosion. Metal ladders should be regularly checked for corrosion, especially around the welds or rivets on the rungs. Timber ladders should be checked for splits and cracks. Wire rope ladders should be checked where the rungs attach to the wire rope and the wires themselves should be checked for broken strands. The fixing points of all ladders should be regularly checked to ensure they are secure and that the rock is sound. Damaged ladders should be properly repaired or thrown away. Timber ladders cannot be safely repaired.

The failure of the winch or any of its components can result in a person falling down the shaft. (Refer to the section on winches under Machinery on page 47).

Unmarked abandoned shafts.

Falling into shafts

There is a high risk of people falling down open shafts.
Tourists in particular may be unaware of the dangers, however miners themselves are also at risk. Vehicles can fall into the larger shafts and people have injured legs and ankles in the smaller ones.

While the dump from the shaft usually highlights its existence, many dumps have been removed, usually by noodling machines. Miners have a responsibility to themselves and others, to make sure that when they leave a claim, the shafts are left in a safe condition. It is suggested that miners who are abandoning a shaft leave a reasonably high ring of dirt around the rim of the shaft.

Weathering ground around the shaft rim can result in a loss of footing when working close to it. Planks across the shaft can also age or split and lose their strength.

Shafts, and in particular hand dug shafts, may become undercut below the rim and could fall in due to weathering and drying out. A person standing above the undercut area could fall into the shaft.

Danger of falling into shafts.

Safeguarding Abandoned Shafts

What appears to be an obvious solution to the hazard of open shafts is to back-fill them, however, there are problems with this. Hang-ups that may occur whilst back-filling may result in a collapse after settling has occurred. Also, a miner could drive under a back-filled shaft that could fall in.

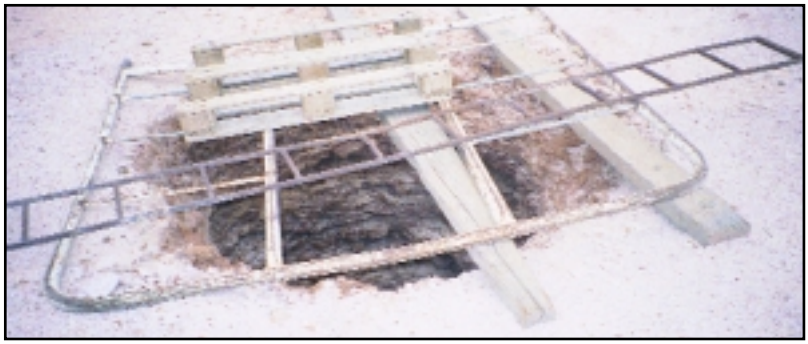
In the past, some miners trying to do the right thing covered abandoned shafts with galvanised iron sheeting. Over time that sheeting has become covered with dust and dirt to the stage where it is not easily visible. At the same time the weather and moisture in the soil has started to corrode the sheeting, resulting in a cover over a shaft that does not have the strength to support a person's weight.

Some other unsuccessful ways of trying to safeguard abandoned shafts have included:

- putting old tyres in them
- putting old rainwater tanks over them
- covering them with old pallets or timber.

Situations of this nature found on a claim (or anywhere on the fields) should be cleared and the top of the shaft marked.

Currently a more practical and permanent solution is being sought to address the problem of open shafts.



Checklist - Shafts

1. Keep shaft rim in good condition (no loose rocks or stones and no fretting).
2. Keep shaft walls in good condition (no loose rocks that may be knocked out and no undercutting of the shaft rim).
3. Keep all services (electrical supply, winch ropes, safety ropes, blower pipes, ventilation bags) free from the risk of damage by things travelling up or down the shaft.
4. Keep support structures at the top of the shaft (timbers, pipes, tripods etc) in good condition and on strong, firm supporting material.
5. There should be at least two means of exit from the shaft (e.g. winch and ladders).
6. Install and maintain adequate lighting.
7. Always ventilate blind or dead spaces in shafts before entry to clear away gases.

Machinery - General

Introduction

Winches and mobile machinery will be covered in detail in the next two chapters. This chapter will address general safety matters common to both, and will also cover noodling machines, generators, drills and blowers.

General Safety

All moving or rotating parts of the machinery must be guarded so that the operator, or others, cannot come into contact with them. Drill operators have been killed or badly injured because they have come in contact with a rotating drill string. A number of miners have lost fingers between the drive pulley and vee belt of a Yorke hoist.

It is important to wear a hard hat when working close to a drill or any high machinery as pins and bolts can work their way loose and fall out.

Stationary machinery, which is driven by, or generates electricity, must be regularly checked and maintained to ensure its safe use. The use of earthing is important and an earth stake combined with a RCD (Residual Current Device) is necessary.

Pre-start check

Always carry out a pre-start check. Items which should be checked include:

- fluid levels
- retaining pins and bolts
- tyre inflation and condition
- track tension
- gauges and lights
- hydraulic rams and buckets - for cracks
- transmission
- hydraulic lines, seals and joints
- hitch /goose neck (scraper only)
- brakes
- steering.

Fuel options

Electric powered machinery is the preferred option for underground use but diesel fuelled motors are the most common and, with the exception of the fume problem, are acceptably safe. Petrol and LPG powered motors must not be used as there is a fire risk. All underground machinery with diesel motors, should have a dry chemical powder fire extinguisher fitted to them.

Exhaust fumes

As with blasting, diesel machinery gives off Carbon Monoxide, Nitrogen Oxides and other gases when running. Breathing in highly concentrated amounts of these gases, even for a very short period can be fatal. If these gasses affect you, there is no guarantee that you will fully recover as they can cause permanent damage with numerous side effects.

The biggest problem with these gases is that you do not notice when they are there. You can't smell them, or see them! In a poorly ventilated mine using a poorly maintained machine, they can quickly build up to a dangerous level, even with only one machine running. Being lighter than air, Carbon Monoxide fills the mine from the high spots down. It acts on the central nervous system and affects the breathing mechanism. Common signs of over-exposure are feelings of drowsiness, headaches then sickness followed by unconsciousness.

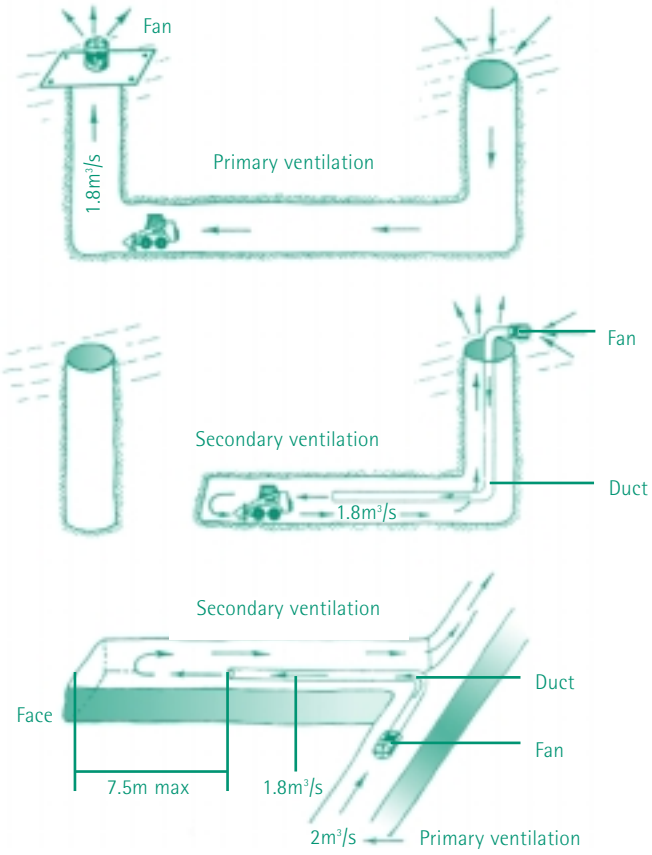
Good ventilation in your mine and proper maintenance on the machines will minimise the risk of Carbon Monoxide exposure. The fuel/air mixture on the machinery fuel system is important and the 'tuning' should be kept in the optimum condition. There is also a need to have all underground machinery fitted with a catalytic converter and a scrubber on the exhaust system. These keep the smoke which contains the gasses and temperature of the exhaust as low as possible. Both the motor and exhaust system need to be more frequently checked than a machine which is not being used underground.

As a part of maintenance work it is a good idea to have the exhaust emissions checked to make sure the dangerous gas emissions are below the accepted safe levels. Safe exhaust gas levels from the machinery are:-

- Carbon Monoxide = Less than 1500 parts per million
- Nitrogen Oxides = Less than 1000 parts per million

Petrol and diesel generator sets obviously have similar exhaust problems and their exhaust should be directed well away from the entry to any underground mine. Petrol-driven generator sets must not be used underground in any situation.

Ventilation for Diesel Motors underground(less than 22.5 kW)



Maintenance

When carrying out small repairs the correct eye protection should be worn at all times, including the proper shields when welding. Wear gloves when doing any welding, cutting or heating work but do not wear gloves when working with rotating machinery (drills, grinders etc).

Never hit hardened steel (e.g. locating pins) with hardened steel (hammer). Steel fragments can fly off with enough speed to penetrate the body.

Noodling machines

Make sure that all in-running pinch points are guarded (drive belts and pulleys, conveyer belts and rollers, drive shafts and motors, etc).

Because of the noise levels in the darkroom the operator should wear hearing protection. If there is dust being released inside the darkroom, the operator should wear breathing protection.

Generators

The exhaust outlet from generator sets should be directed as far away from the entrance to underground mines as possible.

Wear hearing protection when working close to a generator.

Drills

All rotating parts must be properly guarded.

When drilling, it is important to ensure that the coupling between the drive at the top of the drill mast and the auger is secure. There have been cases where this has separated and the whole auger has fallen out forwards. A hard hat will not be of much use in a case like that!

Make sure that the dust extraction is working properly. If there is no dust extraction system, the operator should be up wind of the machinery, or be wearing appropriate breathing protection.

Blowers

Blower pipes must be properly supported at the exit from the shaft.

Blower

Checklist - Machinery - General

General

1. Make sure that all in-running pinch points and rotating parts are guarded (drills, drive belts and pulleys, conveyer belts and rollers, drive shafts and motors, etc).
2. Wear hearing protection when noise is at a high level.
3. Carry out a pre start check.
4. Do not use petrol or LPG powered motors underground - use electric or deisel powered motors.

5. Have a dry chemical powder fire extinguisher on hand.
6. Ventilate to avoid noxious exhaust fumes
7. Wear gloves when doing any welding, cutting or heating work.
8. Do not wear gloves when working with rotating machinery.
9. Have the drill properly maintained (taking special note of the auger coupling).
10. Blower pipes must be properly supported at the exit from the shaft.
11. Check to make sure that the exhaust outlets are directed well away from underground areas.
12. Wear a hard hat when working close to a drill or any high machinery as pins and bolts can work their way loose and fall out.
13. Wear hearing protection and dust protection when working in a noodling machine.

Machinery - Winches

Introduction

There are numerous types of winches in use on the opal fields, ranging from hand wound to complicated electrical driven types. From a safety point of view there are two main things that need to be considered:

1. Is there a chance of the winch failing while a person is riding it, causing them to fall to the bottom of the shaft?

2. Is there a chance of something being winched up or down the shaft, falling on to someone below?

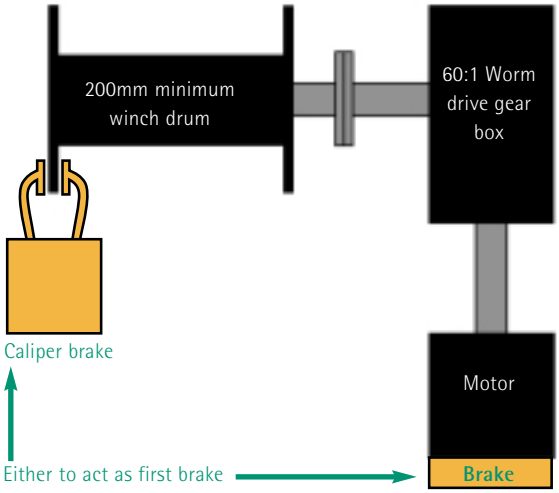
Winches

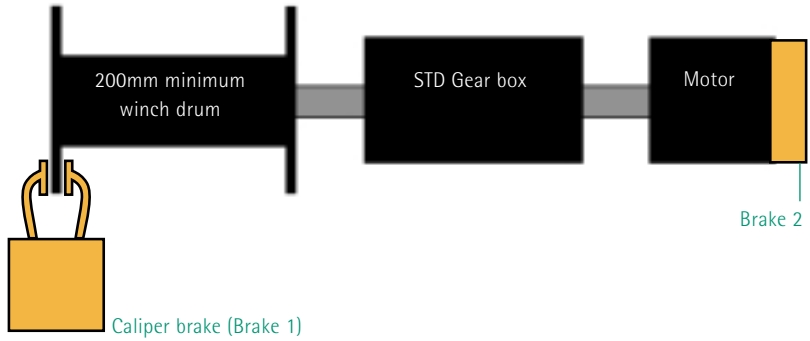
Winches fall into two catagories - those that people ride on and those that are only designed for the transportation of soil to the surface. All winches in the event of a power failure should fail to safety. This means that the brakes should be automatically applied with the loss of power.

Winches that are ridden by people are required to have two braking systems. At least one of these should fail to safety with the loss of power. Winches must be of the direct drive type and must not use friction drives such as 'V' belts.

One popular type of winch construction uses a worm drive gearbox. If the ratio of a worm drive is 60 to 1 or greater, and with the load on the winch there are sufficient losses in the gear box to bring the load to a stop with the loss of power, then the worm drive can be considered as one of the two brakes. There are other acceptable solutions but some designs of braking device are not considered adequate because they are not secure or infallible.

Options for winch drive and braking system



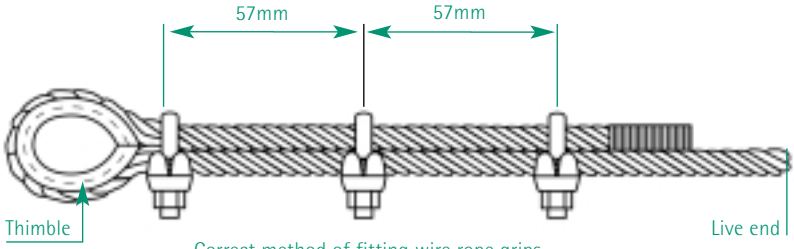


If your winch does not have two braking devices on it, you are not only breaking, the law but you are increasing the risk of serious injury should any thing happen to stop your winch from operating. A friction brake alone is not adequate!

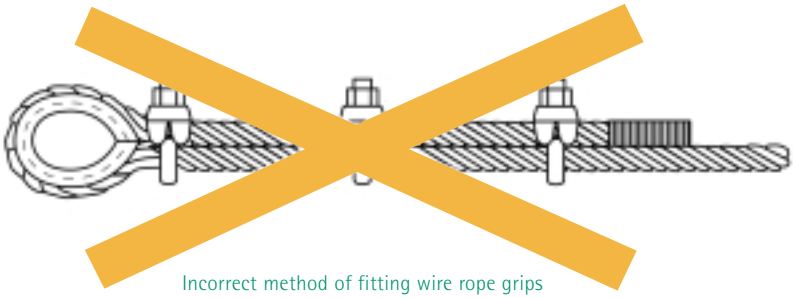
Winches that hoist people must be power driven. There is no way of fitting two brakes to a hand wound winch. A ratchet on a hand winch would only be considered as one brake and a ratchet braking system is not considered safe, as an impact load dropped on the ratchet teeth can result in the failure of the teeth or pawl.

Winch cables and attachments are also an important part of the winch. They should be of minimum quality (6 x 24 FC 1570MPa galvanised wire rope). While 6mm diameter wire rope (with a minimum breaking strain of at least 8 times the normal working load) is legally acceptable, the preferred and recommended size is 8mm.

Maintenance and regular checking of winch cables, clips and connections, could mean the difference between life and death, so it is important to do it regularly. If you find broken strands, the cable should be discarded. Winch cable that is crimped, pinched or bent out of shape is obviously in a dangerous condition, as is winch cable that is showing signs of corrosion.



Correct method of fitting wire rope grips



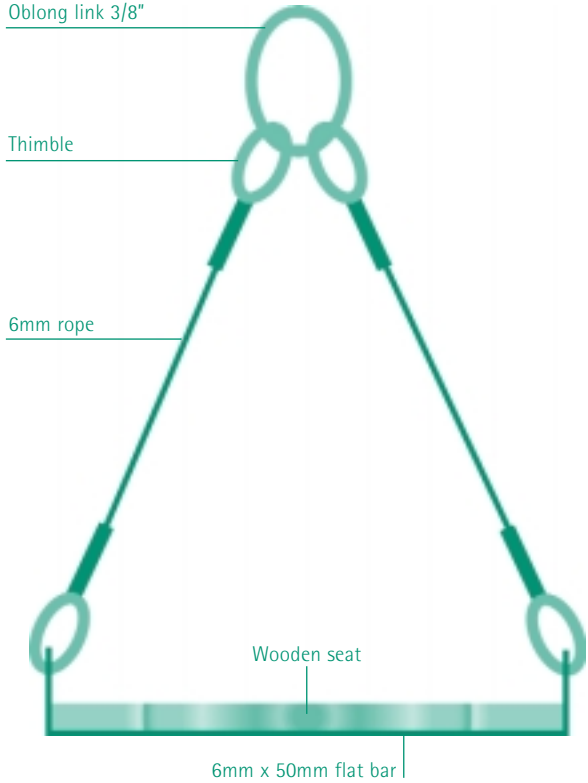
Incorrect method of fitting wire rope grips

Wire rope clips put on the winch cable the wrong way round, (with the hoop over the live end and the thread on the dead end) will reduce the safe working factor of the cable by 50%.

Winch cables are run over a sheave or pulley in all but the most basic of winch setups.

To prevent, or help minimise damage to your cable this pulley must also be maintained in good condition and be the correct size and design for the cable you are using. The centre pin on the pulley should be made from the right material and be the correct size for the job. A mild steel bolt that is about the right diameter is not safe enough for you to hang your life from! A 'keeper' that prevents an unloaded cable from pulling out of the pulley groove should also be fitted above the pulley.

The most common man-riding system is a 'Bosuns Chair' a piece of timber fixed to a hook on the winch cable



Correct set up for a bosun's chair

There are other options, for example a small cage can be made up in which a person can stand. This option, though a bit more complicated initially, would reduce the problems of climbing into the bosun's chair over an open shaft.

Mancage

Mancage fabricated from steel angle, solid floor and roof.

Appropriate size for miner and shaft diameter.

Winch hook attachment 3/8" Oblong link similar to bosuns chair

The connection of the person riding device to the hook on the winch rope must be fool-proof. A fatality has occurred on the opal fields because the connection to the hook was not secure. The preferred option is shown on the bosuns chair diagram. However the connection is made, it is important to make sure that it is correctly put on the hook and that the hook has some sort of device (sprung, one-way latch at best, or wire mousing at worst), to prevent the eye from slipping off.

Checklist - Winches

1. Winches that are to be ridden by people must have at least two braking systems.
2. For a winch cable, use at least 6mm (preferably 8mm) wire rope.
3. Check winch cables, disposing of cables showing signs of wear.
4. Wire rope clips put on the winch cable the wrong way round, (with the hoop over the live end and the thread on the dead end) will reduce the safe working factor of the cable by 50%.
5. Ensure that the end of the winch cable and the bosun's chair cannot fail.

Machinery - Mobile

Introduction

While the mechanical condition of mobile machinery is important for miners to continue work, some things can be neglected without appearing to have an impact on the mining capability of the machine. You should always take care of brakes, steering and exhaust.

These are all important as they can have a major impact on the safety of the miner. They must be regularly checked and kept in the best operating condition. How many miners operating mobile machinery all day go home with an aching back? Often this is because they have neglected to maintain the suspension on the machine or the seat cushioning.

Maintenance

Electric powered machinery, such as tunnelling machines, also need to be regularly checked to make sure that the electrical supply is safe so that the machine, or anything that it comes in contact with, cannot become live.

Exhaust systems should be regularly checked for holes or loose joints. Faulty exhaust systems may make it noisy for both the operator and anyone working nearby. Good, regular maintenance on the fuel, electrical and exhaust system is vitally important to keep exhaust emissions as low as possible.

Operation

When operating a front end loader with a full bucket, keep the bucket down close to the ground. This makes the machine more stable and allows you to see where you are going. The bucket should only be lifted for unloading.

Travelling across a slope obviously makes a machine less stable. The machine specifications will tell you the maximum angle at which the machine can be operated. This is particularly important when working in an open cut in an excavator. The tracks should face up or down the hill particularly when digging below the level of the tracks. When operating a skid steer loader (bobcat), reverse down any slopes when your bucket is loaded.

If you use an excavator to scrape down a face, work with the tracks toward the face and pull the loose material down in front of the machine. When working in an open cut do not undercut a wall above you. When working on the top of the cut, ensure you have solid ground below you and that the area has not been undercut.

If you are doing a lot of work close to the edge of a cut in a front end loader, build yourself a dirt wall around the edge. The dirt wall should be a minimum height equal to half the wheel diameter to protect the machine from rolling over the edge if anything goes wrong. Mobile machinery should be fitted with a ROPS (Roll Over Protective Structure) and seat belt which should be worn when working on any excavation.

Some of the newer tunnelling machines have a hydraulic ram fitted to them which is designed to hold the machine down while operating. The use of this ram eliminates the risk of the machine tipping over backwards while in use and is particularly valuable when working in hard ground. Keep in mind that the ram can de-stabilise the roof above you, so take care when you release the ram pressure from above.

Many tunnelling machines are fitted with FOPS (Falling object protective devices). This is a cage which goes over the operator for protection against anything that may fall from above. Owners of machines that do not have this type of device fitted should seriously consider fitting them as they can be life savers. (They are also required by law.)

To restrict your exposure to dust and noise, keep the door to your cab closed. If the cab is air conditioned, use it to keep the cab air in positive pressure and help prevent the dust from getting in.

Machinery Operators

There is a legislative requirement for you to hold the appropriate licence to operate the following machinery on the opal fields:

- a skid steer loader (bobcat)
- bulldozer
- front end loader / backhoe
- excavator.

No licence is required for:

- tunnelling machines
- graders
- scrapers
- rollers.

Particular skills are necessary to operate this machinery safely and it is important to understand the capabilities of the machinery.

Training to allow you to obtain a licence is not necessary in every case. If you can prove that you have operated the machinery for 24 months prior to April 1995, the licence can be automatically issued to you. If, however, you have not operated this machinery before, or not for some time, you have to undergo an assessment (test) to prove that you can operate safely. Information on who can carry out the training and testing for you is available from:

- the mining and quarrying OHS committee project officer on (08) 8238 5791
- the department for administrative and information services on (08) 8303 0400
- on the internet at www.eric.sa.gov.au.

Bob Cat

Checklist - Machinery - Mobile

Using a scraper

1. Work away from all roads.
2. Make sure you have large enough turning areas.
3. Ensure the working area is free from dips that could cause the scraper to roll over.
4. Make sure the scraper is generally in good safe working condition.
5. Keep clear of all overhead power lines.

Using an excavator

1. Plan work to work up and down rather than across a face.
2. Apply the brake before starting to dig.
3. Ensure adequate swing clearance.
4. When operating, be aware of blind spots.
5. Keep clear of all overhead power lines.
6. Make sure the bucket size is rated for the reach of the machine. Do not over-load the machine by reaching too far for the safe weight of a full bucket.
7. Lower the bucket to the ground when parking. This takes the strain off the hydraulics.

Using a bulldozer

1. Climbing over the tracks can be slippery, make sure you have good hand and foot holds when getting on or off the bulldozer.
2. Try to arrange work so that you do not have to travel sideways across a slope.
3. If operating a bulldozer without a cab, wear a dust mask and hearing protection.
4. Remember, if the blade is high, visibility is low. Make sure people do not walk across your path.
5. Use the weight of the blade for balance when on steep slopes.
6. Don't turn the machine when the ripper blade is in the ground.
7. Do not touch the ripper blade after ripping, they get hot!

Using a loader

1. Travel up hill with the load in front.
2. Travel down hill in reverse.
3. Never work close to loose edges.
4. An articulated loader will become unstable and may tip if turned with a raised, full bucket.

5. Watch for overhead power lines.
6. If operating a loader without a cab, wear a dust mask and hearing protection.
7. Always wear your seatbelt.
8. When tipping a load over a face, the best option is to dump short and push the load over.

Using a skid steer loader (bobcat)

1. These machines are very versatile and can be an asset to any mining operation but they can be unstable and will tip over very easily if misused.
2. Do not overload the machine or over-counterweight the machine:
   - over-counter weighting the machine will make steering and turning difficult and cause excessive wear on the rear tyres and drive chain.
   - overloading the machine may result in it tipping when you lift the load. It will also cause excessive wear on the front tyres and the lifting components.
3. Always wear a seatbelt.
4. Do not carry passengers as these machines are only designed for one person.

Bulldozer

Tunneling Machine

Electrical

Introduction

A number of miners have been electrocuted on the opal fields. In an underground mine, the electricity supply can be as important to the opal mining process as a tunnelling machine or a blower.

Experience and training are necessary to work safely with electricity. When setting up the electrical supply to a mine use the services of a competent and qualified electrician. Remember that electricity can kill!

Electricity seeks the path of least resistance to earth. The human body, which is 80% water, offers an easy path to earth so it is necessary to stay 'insulated' from it. Wet or damp areas increase the danger. The design and installation of the electrical supply should ensure that the miner cannot come into contact with any live electrical supply component.

General Safety

Always avoid direct contact with the current. Generally the lower the voltage, the less the risk.

A regular check should be carried out of the insulation on cables. Those that are frayed or damaged should be repaired or replaced. Electrical cables are designed and rated for the continuous flow of current and the dissipation of heat. If too much current is drawn through a cable, it will begin to overheat, the insulation may burn and cause a short circuit and fire. Fuses should be used to prevent this.

Electrical wiring and repairs must only be done by a qualified tradesman.

Install and maintain adequate lighting and use protected light fittings such as cage lights.

Power Supply

The main power board should be on the surface of the mine in a dry environment, protected from the weather and excessive dust.

Do not use dual adapters, light duty flex or single insulated cable.

Earth steel-framed motors to ground. Generators usually have an earthing lug fitted to the carrying frame. The connection and use of this lug should be discussed with the manufacturer, supplier of the plant or an electrician, having due regard to the requirements that will be placed on the plant and any attachments. When this lug is used, the correct size earth strap and spike should be installed.

When using 240 volt power, always use an RCD (residual current device) at or near the generator. New generator sets are usually fitted with RCDs as a part of the outlet. A check should be made to see if the generator has one and if not, a separate unit can be installed between the generator outlet and the power supply to the mine. It is important to get one with a rating that matches the start up load and continuous current demands of all of the operating plant on the mine.

Very small camper type generators that are designed to run without an earth, do not require an RCD to be fitted These are only designed to power one or two small current drawing devices e.g. a hand held lead light or electric drill.

Always use heavy duty cable. Fixed cable underground carrying more than 110 volts needs to be steel wire armoured. The power supply to electrically powered underground mining equipment should be accessed through an approved trailing cable with earth continuity.

Only use double insulated power tools. Keep power and lighting circuits separate to ensure that any failure of the power circuit still leaves you with adequate lighting.

Cables Above Ground

Cables above ground should be either buried and protected with a cover over them, or strung overhead so that they cannot be damaged by mobile machinery or vehicles driving over them. Overhead cables should not be strung in a place where they could be struck by high reaching mobile machinery moving around the area. Cable used above ground should be heavy duty and resistant to sunlight.

When installing a self tipping hoist with a stop/start control, it is recommended that the control wiring be 24 volts or less.

Cables in Shafts

Whenever possible bring electricity into the mine through a different shaft to the main access shaft.

Electrical cable has considerable weight when long lengths are involved, so cables in shafts should be supported by attaching them to a separate supporting wire or rope. Avoid kinking and inspect the cable regularly for damage caused by falling material.

Install the cable well away from the shaft hoisting mechanism and do not attach the cable to the ladder.

Design the electrical system so that there are no cable connections in the shaft.

Cables in Drives

Cables should be kept off the ground, supported high along the drive wall or roof so they cannot be damaged by mobile plant or falling rocks. The cable should be supported at no more than two metre intervals and be protected at each support point by a sleeve of plastic or similar tubing to avoid abrasion.

Where excess cable is present, looping it back along the drive is preferable to having it coiled up at the end. Coiling the cable while in use can cause excessive heating of the cable and reduce its life. Cables on reels should be fully unwound before use. Avoid sharp bends in the cable.

Cable Connections

Do not use double adapters. A safer alternative is a power board with overload protection and an RCD.

Where plug and sockets are used for cable connections, make sure the sockets are supported on either side to avoid tension. Use waterproof fittings or at least enclose cable connections in some waterproof protection.

Hand Held Tools

Buy heavy duty extension cords which are pre-assembled. They are generally cheaper than home made ones which can be dangerous if incorrectly wired. Plugs and sockets should preferably be of the moulded or clear plastic type.

Do not pull on the cord to unplug equipment. Switch off and then pull out by gripping the plug. Do not use plug and sockets for switching, use switches. Avoid using electrical equipment in wet conditions. Do not leave cords and appliances out in the weather.

Take care while using portable equipment. Be aware of where the cord is in relation to work being done so that cords are not damaged. If power points, switches, cords, plugs, appliances etc, are broken, damaged, or badly worn, have them replaced. Check the operation of the earth leakage protection system regularly and treat any 'tingle' from an appliance as a warning. Do not use the appliance until it has been checked and repaired. Have repairs carried out by a qualified tradesman.

Miners should seek advice from an Electrical Inspector at the Department of Administrative and Information Services. Phone (08) 8303 0400

Checklist - Electrical

1. When setting up the electrical supply to a mine use the services of a competent and qualified electrician.
2. The main power board should be on the surface of the mine in a dry environment, protected from the weather and excessive dust.
3. Ensure that the generator has a RCD fitted or use an RCD in the electricity supply system.
4. Cables which are frayed or damaged should be repaired or replaced.
5. Keep power leads off the ground and away from the risk of accidental damage.
6. Use the services of a qualified electrician to do maintenance and repairs.
7. Wearing rubber soled boots and/or rubber gloves will help insulate the body.
8. Use insulated tools when carrying out maintenance.
9. For cables above ground, bury or otherwise protect them from damage.
10. If above ground cables are strung overhead, ensure they will not be struck by high reaching machinery.

11. Support cables in shafts with a separate wire or rope.
12. Do not use double adapters.
13. Always use heavy duty cable.
14. Install and maintain adequate lighting.
15. Buy heavy duty extension cords which are pre-assembled.
16. Treat a 'tingle' as a warning. Get the appliance checked immediately by a qualified electrician.

Dust

Dust generated by drilling at Lambina

Introduction

All mining creates dust.

Dust can cause skin irritation, allergies and damage to the respiratory system..

Most dust particles breathed in are large enough to be caught within the nose, throat, trachea and bronchial tubes where they are ejected by sneezing or coughing. However, a small number are the right size and shape to get far enough into the breathing system to cause damage.

Silica

Silica is very hazardous to health. It is found in pockets of the sandstone host rock in the opal fields and in particularly high quantities in Mintabie.

Exposure to silica is the cause of a debilitating and sometime fatal lung disease called silicosis. Dust needs to be tested to find out if it contains silica and to do this effectively right across the opal fields would be a major task. Consequently the most practical solution is for all miners to restrict their exposure to all dust as much as possible.

Silica dust can only harm the body if particles are small enough to be breathed into the lungs and retained there (known as inspirable dust).

Dust Controls

There are several ways to control dust.

Try to keep as little dust as possible from becoming airborne and prevent the spread of airborne dust. (eg. extraction/collection systems on drills).

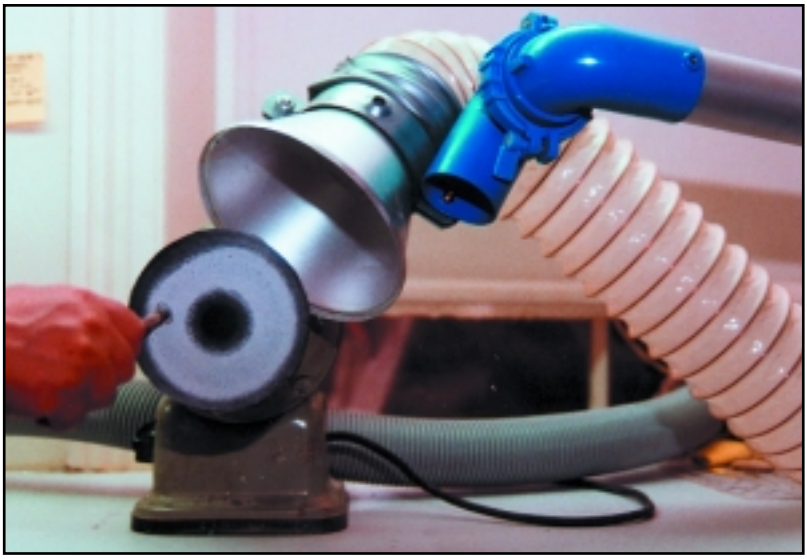
In an underground mine ensure air flow (ventilation) is as good as possible.

Try not to stand in dust clouds. For example try to stay up-wind of the blower outlet. If possible dust-generating machinery should have a local dust collection system.

Wear a dust mask or respirator. Remember, paper dust masks and some cartridge respirators are not suitable for diesel fumes so, if protection from them is also needed, it is important to ensure that the right cartridges are being used. It will be necessary to contact the supplier for information on the correct type of respirator and cartridge.

Cutting and polishing

Cutting and polishing opal also creates a certain amount of silica-bearing dust. As most cutting and polishing is done wet, the dust is usually held within the water and does not become a problem. However some processes are carried out dry and this allows the dust to become airborne. For this reason it is advisable to have the cutting/polishing equipment fitted with an extraction system that sucks the dust away from the breathing zone of the cutter/polisher. Care must then be taken when emptying the collection system of the extractor.



Dust Extractor

Cutting machines

Checklist - Dust

1. Have adequate ventilation to keep the mine clear of dust.
2. Where possible, use dust extraction or collection systems.
3. Ensure that the operator is on the down wind side of the machinery.
4. Appropriate breathing protection should be worn.

Personal Protective Equipment

Introduction

Personal protective equipment will protect the miner from some hazards. Protection from a problem is not as good as getting rid of the problem, but it is better than nothing. For example, fitting a dust extraction system is preferable to wearing a dust mask.

Hard Hats

They may be uncomfortable, fall off and restrict your clearance in small spaces, but in spite of these inconveniences hard hats save lives! Wear one when you are working underground.

They should be worn when working around any high machinery. People have been hit on the head by bolts falling out of drill rigs masts.

When working close to the walls of a cut, a hard hat will provide some protection from rocks falling out of high faces.

Footwear

There is no question that boots, rather than shoes, are better footwear for miners who are working in areas where there is a lot of loose dirt. Boots provide support for your ankles which is important if you are walking in areas where you could roll over on a rock or loose material. They are generally designed with soles that provide better grip in the type of situations in which you are working.

Good fitting boots with steel toecaps will provide you with protection against things dropped on your feet.

Boots are also stronger, better lasting and will stop your shoes from filling up with dirt.

Breathing Protection

Breathing protection comes in various types but there are two main types of masks used on the opal fields - rubber with one or two screw in cartridges, or paper.

Breathing protection does not seal properly on a bearded face and starts to lose its effectiveness if you have any more than a day's growth of facial hair.

The paper mask type is only good for dust and should be worn by people in a dusty environment. If you are working inside the sealed cab of a mobile machine, particularly with an air conditioner running, masks are usually not necessary.

Probably the people at most risk on the fields are those checking behind a bulldozer that is ripping ground and those working inside and outside noodling machine darkrooms. Paper masks are disposable and should be thrown away when breathing through them becomes difficult.

The rubber masks have cartridges that can be removed and replaced when breathing becomes difficult. Cartridges can be bought that are suitable for different risks. Those most commonly needed in the fields are:

- dust - for use as above.
- dust and fume - For those mining underground with diesel equipment where the ventilation is not adequate.

The dust cartridge will not provide protection against the fumes from the diesel exhaust. You must have a fume cartridge which will also provide protection against the dust.

There are numerous manufacturers that have different brand names and part numbers for the different respirators and cartridges. You will need to contact the supplier or manufacturer to ensure you have the right type.

Hearing Protection

Hearing protection comes in two general types- ear plugs and ear muffs. While muffs are generally more uncomfortable to wear, plugs get dirty and can cause ear infections. The expandable foam type, which are sold as 'disposable' should be thrown away when they get dirty and lose their elasticity - usually after a day's use.

Hearing damage can occur when noise levels exceed 85db(A) This is roughly equivalent to standing next to a heavy truck on the road, so a bulldozer under load is well above that. A jack hammer in use will produce something like 110db(A) which can permanently damage your hearing in less than five minutes.

In broad terms ear plugs generally cut out about 20db(A) so they will usually provide adequate protection. Occasionally, where the noise is at a higher level, it may be necessary to use the higher level muffs. Lower level muffs, which only cut out the same as the plugs, are also available, so you need to make sure you get the right type.

Eye Protection

When working either in the open, underground or around a workshop at home, there is a risk of getting things in the eye. Particularly in a workshop environment, flying metal can cause anything from a minor scratch to the surface of the eye to a total loss of the eye. Wearing eye protection can assist in preventing this.

When working out in the sunlight, dark tinted lenses will assist in preventing ultra violet damage caused by too much sun exposure.

There is a problem with eye protection, particularly glasses, misting up. Some manufacturers claim that they have a product with a non-misting lens, or they can sell you a wipe-on product that will prevent misting. These are not very effective and the only answer is to make sure you have good ventilation if underground, or keep cleaning them. This is less of a hassle than walking around with only one eye!

There are numerous types, styles and brands available but the thing to check for is the Australian Standards Triangle and number, AS1337. This indicates that the glasses meet the appropriate safety standards.

Checklist - Personal Protective Equipment (PPE)

1. Try getting rid of the problem rather than relying on PPE for protection (eg dust extraction is preferable to a dust mask.)
2. Wear a hard hat when underground, working close to the walls of a cut and around rigs or high machinery.
3. Wear good fitting boots with steel toecaps to protect and support the feet.
4. Wear appropriate breathing protection for dust, or dust and fumes.
5. Wear ear plugs or ear muffs for protection against noise.
6. Wear safety glasses to protect eyes from dust and flying objects.
7. Wear UV protection when in sunlight.

First Aid

Introduction

If a person is injured underground and is not able to get to the surface, you should call the Mine Rescue for assistance. If you try to move an injured person out of an underground shaft access mine without Mine Rescue assistance, the injuries could be made much worse.

Many accident victims have died purely because people on the scene did not know enough first aid to make sure the injured person was breathing. If there are only two of you working alone, you owe it to yourselves to be properly trained in first aid and if possible, to have an easily accessible means of communication to obtain assistance.

It is strongly recommended that miners do not work by themselves.

Mine Rescue

When notifying the mine rescue personnel, be sure to give them your exact location. If the injured person is down a shaft you must stay on top, or *leave some very clear indication at the top of the shaft* as to where the injured person is. Valuable life-saving time can be lost trying to find the injured person.

If you personally attend the police station or hospital, you should stay there and the rescue squad will pick you up from there.

If you call by phone you need to give the following details:

- the name of the field
- access gate number
- equipment nearby (e.g. near the yellow blower)
- the location of the mine, if available. Send them to the access gate or a known point
- the type of accident. (e.g. cave-in, explosives, fumes, machinery, fall)
- number of people involved.

General First Aid

If an injured person is conscious, attend to any serious bleeding by the application of pressure using anything you can to cover the wound such as a shirt or rag, then go for assistance.

If they are not conscious, **do not leave them with their chin on their ches**t. If possible, gently roll them onto their side, check and clear anything from their mouth and gently tilt their head back to open their airway. Try not to move them any more than is necessary and leave them in a position where they can breathe. Breathing is higher on the priority list than spinal injuries. Then go for assistance. Even if you feel confident doing EAR (Mouth to Mouth) and CPR (Heart Massage), you must let someone know of the situation, otherwise you could be doing it for hours on your own. If resuscitation is needed, do one full minute before going for help.

Once you have notified someone of the situation and you are sure help is coming, then you can go back and try to help in any way you know best.

Shock

Shock can often accompany even moderate injuries. In all cases of severe injury, First Aid for shock should be given immediately. Don't wait for shock to develop first. Act first - act fast - keep the injured lying down, keep the injured warm.

Any or all of the following symptoms may manifest themselves immediately, or after the injury.

- Weakness, feeling faint, mental sluggishness or collapse.
- Pale face with skin cool and clammy.
- Drooping eyelids, pupils dilated or a vacant look on the face with dull eyes.
- Rapid and shallow breathing.
- Nausea and/or vomiting.
- Pulse may be fast, irregular or weak. The pulse may be too weak to feel.
- Unconsciousness.

To treat for shock, lay the injured flat on their back, face up. Loosen any tight clothing and elevate the feet about 30 to 50 cm (Unless there are head injuries when the head should be raised, or there are chest injuries or difficulty in breathing when head and shoulders should be raised.)

Keep the injured warm but do not heat, placing blankets or a suitable alternative UNDER as well as over the injured person. In hot weather covering is not generally required. If the injured person complains of thirst moisten the lips with water. Care as best as you can for the injuries and keep the injured quiet and comfortable while waiting for medical assistance to arrive.

Deep or Extensive Wounds

Try to control bleeding by applying firm pressure over the wound, preferably with a clean cloth. When bleeding has been controlled bandage the wound firmly but not tightly.

If bleeding from a wound on a limb continues unabated, apply pressure to the artery that supplies the limb. Should all else fail, a tourniquet should be applied. This should, preferably, be of flat material about two inches (5cm) wide and applied on normal skin about one inch (2.5cm) above the wound. Once applied, the tourniquet should only be removed by a doctor, who should be informed of the time that the tourniquet was applied.

Wounds with Foreign Bodies such as Metal, Sand, Gravel, Glass, etc

Do not attempt to remove foreign bodies, except for those that can quite obviously be picked off easily. Control bleeding by applying pressure to the surrounding areas but not to the foreign body. Place padding around the object.

It is better to cover the wound, foreign bodies and all, with a clean dressing and seek medical assistance as soon as possible, make sure that you do not exert pressure on the foreign body/bodies.

Fractures (Broken Bones)

If a fracture is suspected, treat it as the real thing until a doctor tells you otherwise Apply pressure to control any bleeding. Never try to push a protruding bone back into place.

Treat the injured person for shock. Do not move the injured person more than is absolutely necessary. Get medical assistance as soon as possible.

Burns and Scalds

To treat a burn, remove clothing from the burn, carefully cutting around any that is sticking to the skin. Wash with cold water and cover the burned area with a clean cloth.

There are a number of very important "don'ts" relating to burns:

- don't touch the burn with anything that is not clean.
- don't use butter, oils or boracic, tannic or picric acid based ointments on burns.
- don't put absorbent cotton or blankets on a burn with broken skin.
- don't break or drain blisters.
- don't delay initiating treatment for shock in cases of serious burns.
- don't delay getting professional medical assistance.

Administer first aid for shock, make the victim comfortable, then seek medical treatment quickly.

Exposure to Heat

Over exposure to heat is not always easy to recognise but generally the victim may have a headache, feel hot and giddy and feel tired or exhausted. Movements may be uncoordinated, the victim may be difficult to reason with, reaction times may be slowed, speech may become slurred, sense of touch may be impaired and lips and hands may swell.

There are various stages to heat exposure: sunburn, heat, cramps, heat exhaustion and heat stroke. Excessive consumption of alcohol may make the situation worse.

To treat, move the victim to a cool or shady area and sponge with cool water. Give plenty of fluids in frequent small amounts but no alcohol or other stimulant. Apply ice packs to cramped muscles

If unconscious, place the victim on their side. Loosen any tight clothing and remove any excessive garments. Cool the victim by sprinkling with water or wrap in a wet sheet or towel. Continue these measures until the body feels cold to the touch and then seek urgent medical assistance.

Snake Bite

Reassure the victim. Be more concerned about the victim than identifying the snake. Only take the snake to the medical centre if this can be done without risk or time wasting. Venom detection kits are widely available.

Symptoms that may develop 15 minutes to two hours after being bitten include sweating, a headache, vomiting, breathing difficulties, double vision, drowsiness, pain or tightness in the chest or abdomen, diarrhoea, giddiness and faintness. Unconsciousness and breathing failure may occur.

To treat, never wash the venom off the skin as the venom left on the skin will aid in identification of the snake. Never cut or excise the bitten area. Never try to suck the venom from the wound. Never use a constrictive bandage.

Keep the victim quiet, avoiding activities that will increase the pulse rate. Reassure the victim as the emotional reaction can be severe.

Immediately apply a pressure bandage over the bitten area. Bandage from the bite down to the extremity of the limb, then back up to the junction with the trunk and bandage as much of the affected limb as possible. (But not so tightly as to restrict the blood flow to the limb below the bandage.) Place a splint along the bandaged limb using another bandage and do not remove the splint or bandages once applied.

Seek medical assistance urgently. Anti venom is available for all Australian snakes.

Coober Pedy Mine Rescue emergency phone number is 8672 5999

Andamooka Mine Rescue emergency phone numbers are
(Police) 8672 7072, (Clinic) 8672 7087, (Post office) 8672 7007

Mintabie Mine Rescue emergency phone numbers are
(clinic) 8670 5032, (SES) 8670 5162, 8670 5037 A.H.

Checklist - First Aid

1. Do not work alone.
2. For serious injuries, call Mine Rescue.
3. Control serious bleeding by applying pressure.
4. If a person is not conscious, if possible, gently roll them onto their side, check and clear anything from their mouth and gently tilt their head back to open their airway.
5. Do not move patient more than necessary.
6. In all cases of severe injury, First Aid for shock should be given immediately.
7. Go for assistance.
8. Give Mine Rescue clear instructions including:
    - the name of the field.
    - access gate number. (at Coober Pedy only)
    - equipment nearby (e.g. near the yellow blower).
    - location of the guide, if available. Send them to the access gate or a known point.
    - the type of accident. (e.g. cave-in, explosives, fumes, machinery, fall).
    - number of people involved.
9. Stay on top, or leave some very clear marker at the top of the shaft.

Appendix A
Ground Structure

Aim

The ground conditions in the South Australian opal fields vary considerably between mines and even within individual mines. In addition, every mine needs to be laid out differently. These variations mean that no guidelines can offer you a formal "code of practise" for designing and supporting your underground mine. However, when combined with your experience in your ground and the experience of others nearby, these guidelines can provide you with a solid foundation, based on practical experience and sound theory, upon which you can create a stable excavation.

Introduction

The claystone and sandstone around the South Australian opal fields ranges in strength from "very weak" when weathered near the surface to "weak" at depth. No matter how strong it is in compression ("squeezing") it is about 15 times weaker in tension ("pulling"). If the rocks fail in tension, they give little warning of failure. Your mine is probably located at a depth of less than 20m but some go to 35m. At these depths the rock in the roof of your excavation or "ballroom" is usually under tension (Figure 1). The wider your excavation, the greater the tension.
Too much tension and the rock fractures, geological structures open up and rock-falls occur. These falls occur rapidly and can involve a large amount of rock. They have killed many people on the opal fields. The strategies outlined in the following section aim to minimise the likelihood for these rock-falls occurring by limiting the height and width of the tension zone and by designing the excavation in such a way that the ground can carry the loads.

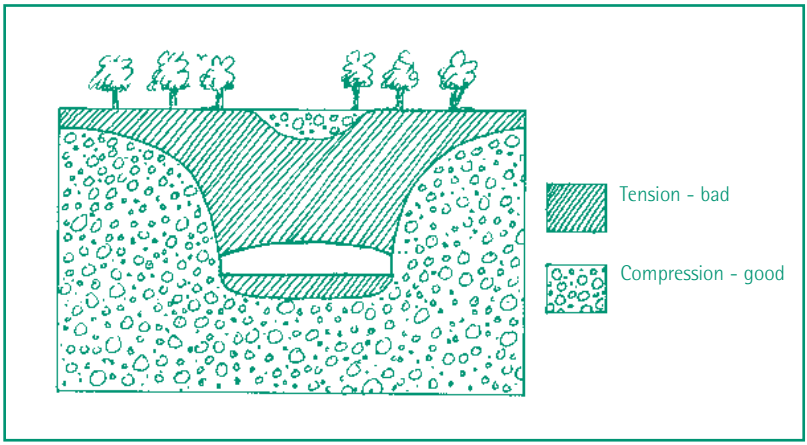


Figure 1: Cross section showing tension zone surrounding a shallow excavation.

General

The layouts of tunnels and ballrooms are dictated by the requirements of mining an opal deposit. However, where possible, you should consider the geology and aim to avoid bad ground and major geological features such as faults. These features often show signs such as cracks associated with them, which should also be avoided. In some cases, the ground will be so bad that it would be unwise to mine it at all unless specialised support measures are used.

The bigger you make your excavation, the more rock you will expose. The more rock exposed, the greater the likelihood that you will expose geological weaknesses. The more weaknesses exposed, the weaker will be the rock surrounding your excavation. Therefore, aim to keep the dimensions of your tunnels and ballrooms as small as possible to minimise this reduction in rock strength.

The closer a mine is to the surface, the more likely it is that any geological features will be weathered, open and large, thereby increasing the likelihood for rock-falls to occur. The likelihood for rock falls to occur is increased even further if rainfall has allowed water to get into the rock.

Pillars

Aim to keep the total **area** of rock you mine out to about 45% to 50% of the total area (Figure 2). The remaining 50-55% of the area should be left as a regular system of vertical **pillars**. Each pillar needs to be sufficiently large to carry the weight of the rock above it and above the adjacent excavation for many years. The pillars may be developed in blocks of unprofitable ground.

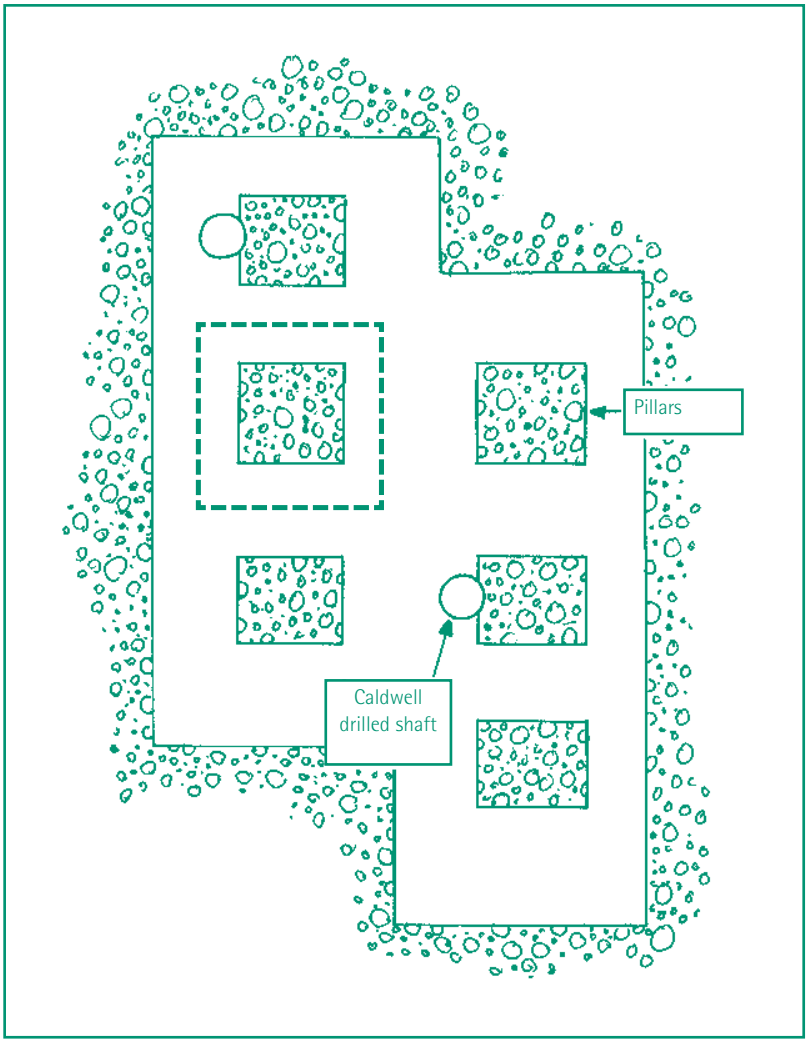


Figure 2: Plan view of room and pillar mining operation showing area of roof carried by single pillar.

As shown in Figure 3, pillars can be rectangular, square or rib shaped or, as is often the case in the South Australian opal fields, irregular or random shape.

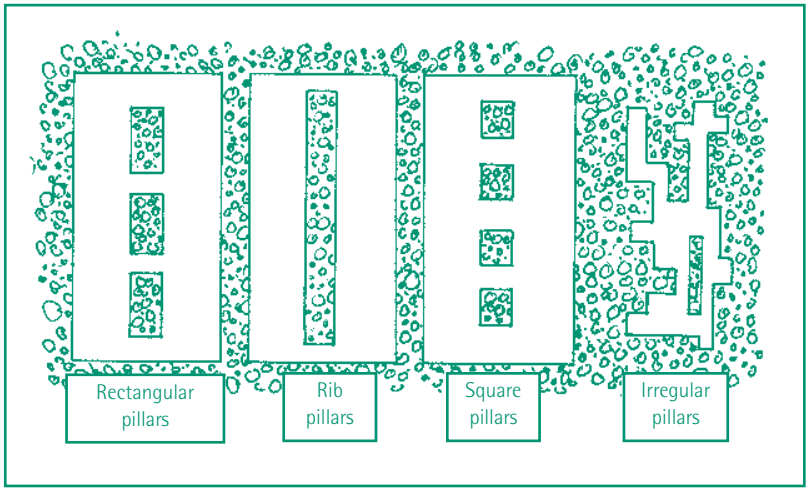


Figure 3: Pillars can be rectangular, rib, square or irregular in shape.

The ground in a pillar has been unexposed for thousands of years. As the ground on either side of it is excavated, the material in the pillar suddenly expands as it takes up the load that was once being carried by the newly excavated ground. This expansion, and the sudden addition of load, can cause the pillar to fail without warning. Even extracting only small volumes of rock can throw large additional loads on to a pillar, which can trigger failure. Sudden failure is particularly common when the pillar is located close to the intersection of several tunnels or larger excavations.

A pillar will often contain small cracks. Over time, these cracks grow and the rate of growth increases with time. By the time a 1mm long crack has grown to 10mm, only 1/3 of the original load will be required to keep it growing. The growth of the cracks will cause the strength of the pillar to reduce. A further reduction in strength can occur if the outer "skin" of the pillar has been slowly deteriorating over time from the effects of moisture and ventilation air. For these reasons, check your pillars regularly for signs of instability. Figure 4 shows some of the signs you might see.

"Pillar bashing" is not an advisable practice. There would be a good reason for leaving a pillar where it is. However, if you are going to do it, you should use retreat mining methods. This means that you work the lowest level and furthest away from the exit first then work your way back towards the shaft or exit, as shown in Figure 5.

At a depth of 25m, the **width** of the pillars should be no less than 3m in good ground and no less than 5m in bad ground (figure 6). At smaller widths than these, any defect in a pillar can significantly reduce its ability to carry load and adjacent pillars will have to carry the weakened pillar's load. This additional load can cause the adjacent pillars to progressively fail in a "domino" type manner.

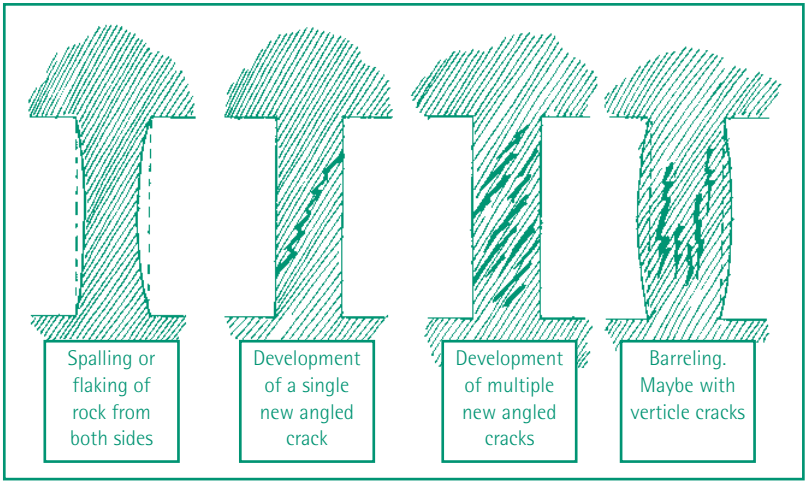


Figure 4: Cross section showing signs of possible pillar failure.

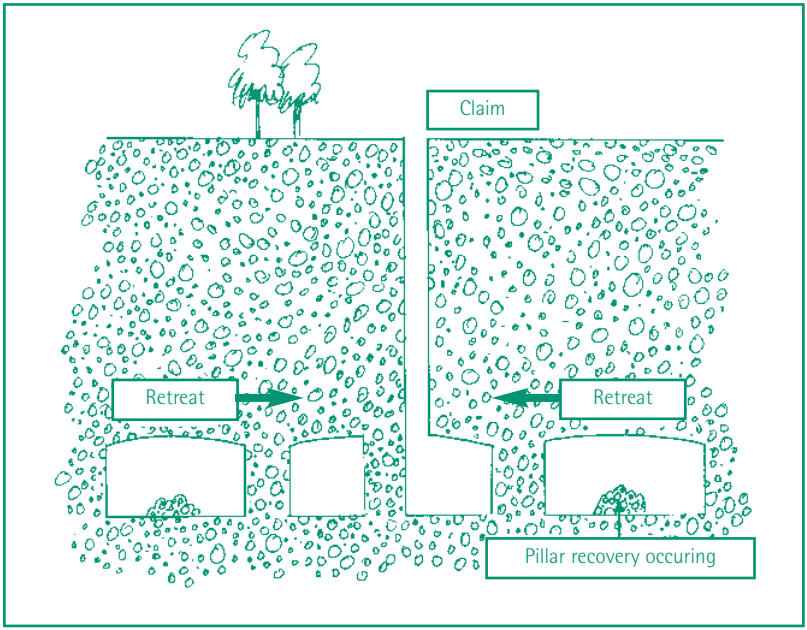


Figure 5: Cross section showing pillar recovery occuring from the extremeties of the claim.

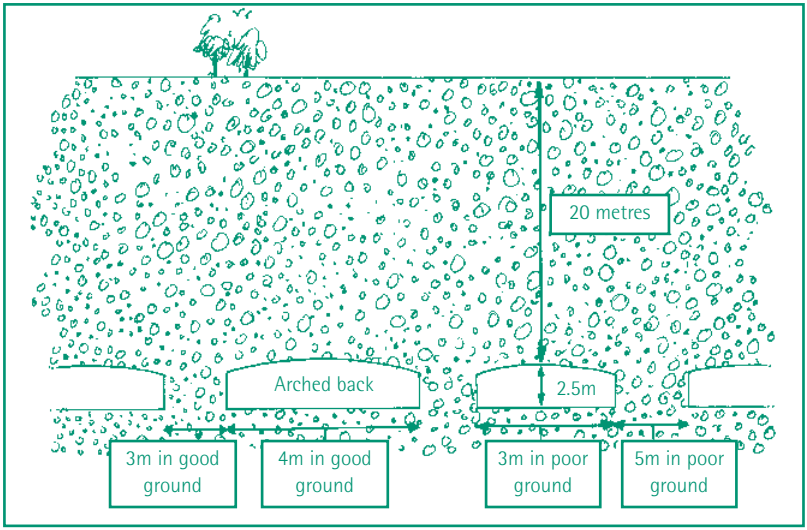


Figure 6: Height and width of pillars.

The **height** of a pillar should not exceed 2.0m to 2.5m which should be the normal mining height around the South Australian opal fields.

Regular pillars should be **vertically aligned** (Figure 7) so that mining beneath a pillar that is carrying the full load of the strata above it does not occur.

Don't **tunnel under or through any pillar**. Aim to reduce the span of all tunnels to a minimum and provide additional support if necessary.

If you mine on multiple levels or under old workings, aim to leave a **crown pillar** (Figure 8) between levels of at least 4m thickness in good ground and 5m in bad ground.

Leave a substantial rib pillar parallel to a dozer cut face (Figure 9).

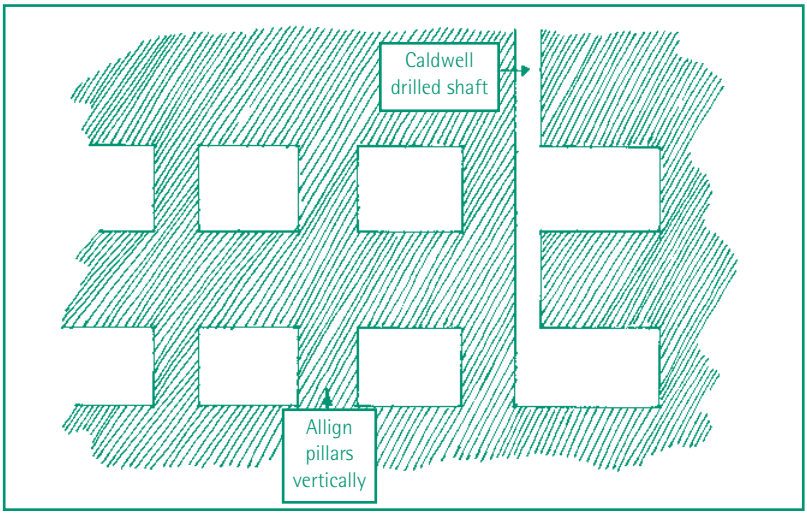


Figure 7: Multiple level mining with pillars aligned vertically.

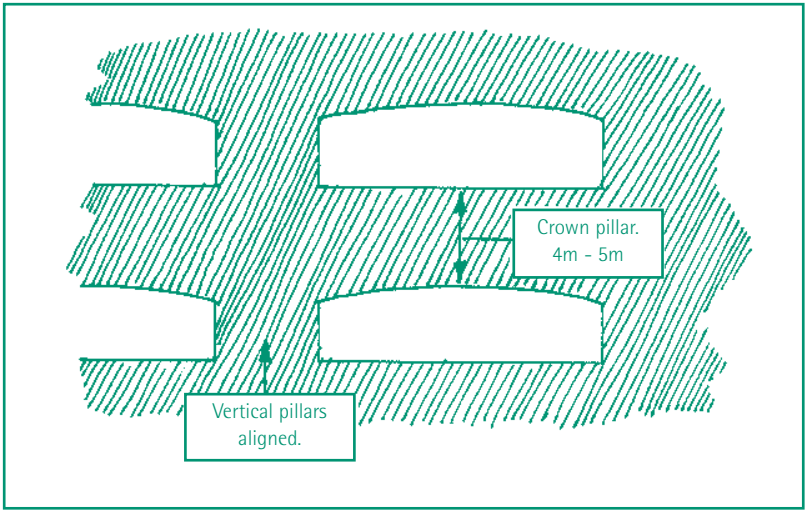


Figure 8: Cross section showing a crown pillar.

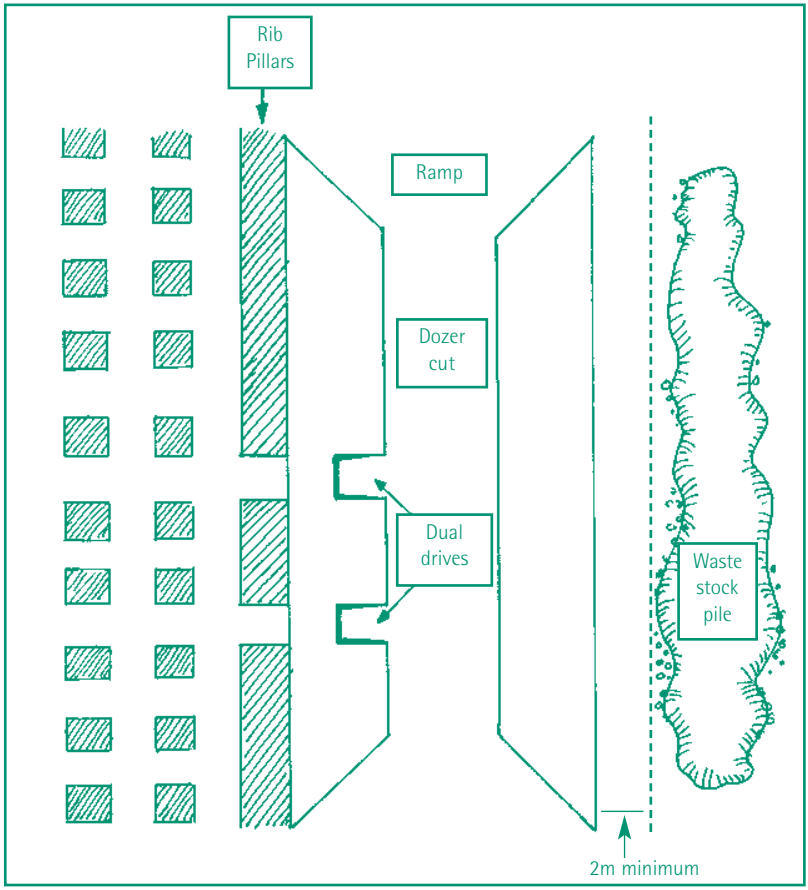


Figure 9: Leave a substantial rib pillar parallel to a dozer cut face.

Spans

In general, the maximum **span widths** of excavations should be no more than 4m in very good ground and no more than 3m in bad ground (Figure 6). However, spans of any dimensions have failed in the past so get into the habit of checking daily for signs that your roofs are becoming unstable.

Rock loses strength over time so a roof dug in fresh rock that appears stable initially may fail suddenly at a later date once the rock has weathered, dried out and deteriorated. This occurrence is even more likely if the rock contains geological weaknesses.

Unfortunately you can't see inside the rock so you can't see cracks developing inside it. By the time these cracks reach the surface they will usually be well advanced. If you don't look out for them and notice them as soon as they appear, it will eventually be too late to do anything to control them.

Shafts

Your **shaft** should pass through ground free of geological weaknesses. In particular, try and avoid ground containing faults. Small pieces of loose rock in the faulted zone can dislodge into the shaft and cause larger blocks of rock to dislodge. If your shaft passes through bad ground, you may need to redrill it elsewhere.

Calweld drilled shafts are significantly more stable than are square or irregular shaped shafts sunk by hand or blasted.

To prevent deformation and deterioration of your shaft as mining proceeds and as a result of ventilation air drying out the rock surrounding the shaft, a **shaft pillar** of unmined ground should be left around the shaft (Figure 10). The diameter of the pillar should be at least 4m times the diameter of the shaft. Therefore, a 4m pillar should be left for a 1m Calweld drilled shaft.

The shaft can have a timber or galvanised iron boxed collar installed on the surface. This collar prevents the opening of the shaft from being undermined and prevents soil or rock falling from the surface. This could damage the shaft and injure workers. A ring of dirt should be placed around the collar and gently sloped back from the collar to help prevent rainfall runoff from entering the shaft.

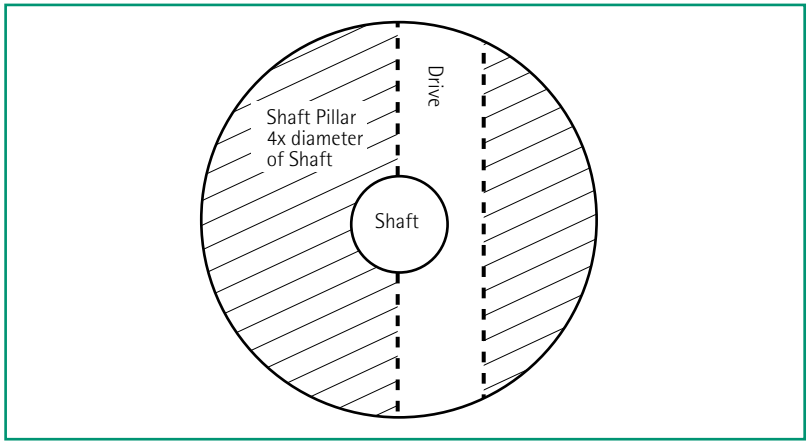


Figure 10: Plan view showing relative dimensions of shaft and shaft pillar.

Blasting

Excavations produced with a tunnelling machine tend to be more stable than those produced by drill and blast methods. Rough blasting can generate excessive fracturing which can break the roof and sidewalls into unstable blocks. A similar affect can occur if the spacing between the holes is too small, too large or if holes misfire. What will remain after a rough blast will be the remnant of what could have been a stable excavation.

One of the most frequent causes of accidents is inadequate **scaling** or barring down particularly after a blast. Scaling should be done at any time rock appears to be loose. Use a proper 2 metre scaling bar and keep well away from falling rocks. Never use a pick for scaling above waist height.

Driving from a pit

If driving underground from the floor of an open cut, a **portal** (Figure 9) can be installed into the entrance of the drive to provide protection and support to the adjacent rock. This portal should continue into the drive until you have at least 5m of ground above the roof and the rock appears to be good and not blast damaged. While driving, continue to inspect the ground and if necessary provide additional support if geological features are encountered and/or the ground becomes bad.

Blasting the drive will dislodge and loosen rocks from the slope face above. These rocks must be removed. If an excavator is available, it can be used to scrape the face free of loose rocks.

A **brow** should extend out from the entrance to protect workers from rocks that fall from above. The longer the brow the better, however, the minimum distance in good ground should equal the width of the entrance.

The slope above the entrance should be benched every 5m down from the surface (Figure 9). Benching acts to lower the overall angle of the slope which makes it more stable. The benches act to catch rocks that dislodge from above and they should be between 3m and 5m in width. They should be regularly cleaned to prevent rocks from building up on them.

Take note of the batter angles on the slopes of your pit and those on adjacent pits that are in similar ground. Note which of these slopes show signs of past instability and which have remained stable. Take particular note of those slopes that face the same direction as the one that will contain your drive. Angle batters 10 to 20 degrees off vertical for stability.

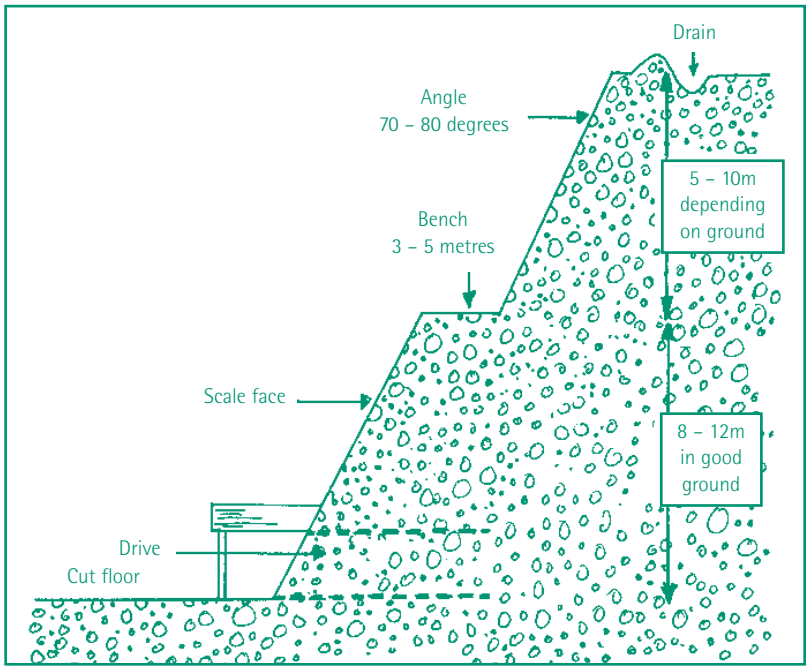


Figure 9: Cross section through a cut slope constructed for stability improvement.

It may not rain often in the South Australian opal fields but when it does it can pour down. Water can have a bad influence on the stability of a slope and one heavy downpour can do a lot of damage to a slope and the rock within it. Aim to prevent water from getting into your slope through surface cracks and other geological features by using surface drains to collect rainfall run off well before it reaches the crest. These drains should be steeply angled and kept clean to prevent water from ponding in them. If needed the drains can be lined with heavy plastic sheet.

Prevent water from entering surface cracks by filling them full of gravel and then sealing them over with clay.

In summary

No one knows your ground better than you. **Learn** what works in it and learn from it when things don't. Don't tempt fate by being greedy and don't try to push spans or pillars beyond what is safe for your mine.

The characteristics of every underground mine are different to every other mine and, therefore, every mine should be designed individually. It is impossible for these guidelines to cover every condition that might apply at your mine. If you have any queries about your design or support requirements please consult a Mines Inspector for advice.

Checklist – Excavation Design and Ground Support

1. Consider the geology and avoid bad ground.
2. Keep the dimensions of your excavation as small as possible.
3. Initially only excavate about 45% of the total area. The rest of the ground should be left as pillars to be recorded on completion.
4. Check the pillars regularly for signs of instability.
5. Examples of dimensions that have worked around Coober Pedy are listed in the table below.

   However, never forget that smaller spans and wider pillars have failed.

	Good Ground	Bad Ground
Maximum height of excavation	**2.5m**	**2.5m**
Minimum width of pillar	**3m**	**5m**
Maximum span of excavation	**4m**	**3m**

Minimum crown pillar thickness	**4m**	**5m**
Shaft pillar	**4 X shaft diameter**	

6. Level pillars should be vertically aligned.
7. Don't tunnel under or through pillars.
8. Additional support should be provided in bad ground. This support may be provided with extra pillars or props.
9. The backs of excavations should be arched.
10. Choose ground free of geological weaknesses to site shafts.
11. Calweld drilled shafts are more stable than hand sunk square shafts.
12. Leave a shaft pillar of unmined ground around the shaft.
13. Shaft collars can be boxed in and water must be kept away from the collar.
14. Rough blasting should be avoided.
15. Regularly scale down loose rock.
16. A portal can be installed into the entrance of a drive in a cut.
17. A brow should extend beyond portal.
18. The slope above a portal should be benched and the benches should be sufficient width to collect rocks.
19. Water should be kept away from slope of faces.
20. Recover pillars by a retreat mining method starting farthest away from your shaft and progressively work towards it.

Appendix B
Legislation

Introduction

The aim of this chapter is to introduce the legislative requirements of opal mining. The intention is to give an overview, and point you in the right direction rather than give comprehensive details of the Acts and Regulations. Besides the fact that they are legal requirements, its worth taking notice of them for your own safety and those around you.

First you will need to work out if you are an employer, an employee or self employed because the legislative requirements are different for each. Most opal miners will be self employed.

There are also particular responsibilities for occupiers and owners of buildings, for owners of plant and for designers of plant. (If you modify plant or make something to suit your own needs, you are a designer.)

The Occupational Health Safety and Welfare Act, 1986

This Act is the main one for employers, employees and self employed people in South Australia. One of the main requirements under this Act is duty of care. This means that you have a responsibility to do everything reasonable to keep yourself and others from injury or ill health in the workplace.

Occupational Health, Safety and Welfare Regulations, 1995

The regulations talk about the responsibility of employers to carry out hazard identification, risk assessment and control of risks. You may already be doing this. If you are regularly checking over things that could cause injury or bad health, such as your winch clip, the roof of your mine and the ventilation, and if you are fixing things that are not safe, then you are probably already complying with this.

If employees become aware of something which is not safe, they must take all reasonable steps to protect the health and safety of themselves and others and they must report the problem to the employer.

Most opal miners are self employed. If so you should be doing everything you can to ensure your own safety and health and that of others, so you also should be checking things over and fixing things that are not safe. This may include notifying persons in an adjoining mine when blasting takes place as ground vibration or dangerous gases may go into their mine.

There are some parts of the regulations which will be important for opal miners, (for example, Part 3 which is about plant). Get a copy of the regulations and work out which parts apply to you. You can then make sure that you are complying.

Division 5.13 - Opal Mining (OHS&W Regulations, 1995)

This has been an extra section added to the regulations at the request of the opal miners. They are more specific about things relevant to opal mining and they have the following aims:

(a) that risks to the health and safety of people who are opal mining or in the area of an opal mine, are identified before work begins.

(b) that problems are fixed before, during and after opal mining has taken place.

(c) that opal mining is carried out in a safe manner.

These regulations again emphasise the importance of checking everything thoroughly and fixing anything that is dangerous

The Opal Mining Regulations cover the following specific risks:

- Underground fires
- Ground support for an underground mine
- Ground support for a surface mine
- Diesel engines
- Winches
- Shafts and drill holes
- Electricity and Cabling
- Ventilation
- Explosives.

As you can see from this list, these regulations are very relevant to opal mining and it is strongly suggested that you become familiar with them.

Summary

The Acts and Regulations listed here are the main ones for opal miners, but they may not be the only ones that apply to you. Depending on the things you do and the substances you handle, other Acts which may be relevant include:

- The Explosives Act, 1936
- The Dangerous Substances Act, 1979, and
- The Mines and Works Inspection Act 1920

Have a closer look at these Acts to find out if they are relevant to your work.

Coober Pedy Mine Rescue emergency phone number is 8672 5999.

Andamooka Mine Rescue emergency phone numbers are (Police) 8672 7072, (Clinic) 8672 7087, (Post office) 8672 7062.

Mintabie Mine Rescue emergency phone numbers are (clinic) 8670 5032, (SES) 8670 5162, 8670 5037 A.H.