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ENVIRONMENTAL MANAGEMENT OF EXPLORATION AND MINING

RESOURCE MANAGEMENT BRANCH

by

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ENVIRONMENTAL MANAGEMENT OF EXPLORATION AND MINING

INTRODUCTION

Minerals have been extracted from the earth ever since utensils and ornaments were fashioned from clay and stone buildings were used for shelter.

But mining is considered by some to be such a damaging land use that it should be severely restricted and even prohibited in some areas.

Today mineral and energy products are the very basis of life - for cooking, transport, food production, medical services and countless other uses.

As we need minerals we also need the mines and quarries which produce them.

And we need to find new deposits to supply the needs of future generations.

The early mines in Australia supplied the needs of the settlers, established new towns, provided employment and generated considerable national wealth. They also destroyed vegetation and interfered with natural systems in the same way, although not on the same scale, as those of today. Time has healed the environmental damage from most of these early operations and today they have considerable heritage value with growing tourist

potential. Rehabilitation practices developed over the last ten years give assurance that permanent environmental damage from the mines of today can also be prevented.

Why is it then that many conservationists are so opposed to mining?

The answer lies in two historical events - one very old and one very recent.

The location of mineral deposits was fixed by geological events of the past. As a consequence, mineral workings must be opened where these essential resources are found rather than where the planner would wish to place them. However, mineral deposits often coincide with significant landscape and other natural resources and some interference with these must occur if we are to enjoy the benefits which minerals provide.

Mineral deposits are comparatively rare but prior to World War 2 demand was met from underground workings and small open cuts located mainly in rural areas.

The dramatic growth in population after World War 2 precipitated an equally dramatic expansion of urban areas and industrial development. The consequential increased demand for mineral and energy products required widespread exploration to find new resources and the opening of large scale open cut mines to supply the growing needs of the population.

Governments possessed few regulatory powers to manage this growth in the early post war years and environmental degradation occurred on a scale not seen before.

Nevertheless the area of natural surface resources destroyed by the new mines was small in comparison with that converted to urban living and cleared for agriculture.

However, new and pleasant landscapes were established quickly in the new urban and agricultural areas whereas most mine sites must wait for many years until the deposit is depleted and rehabilitation is effective.

Mining is one facet of the sequential cycle of land use shown below:

prior use
exploration
appraisal
development
production
rehabilitation
after use

It is necessary to understand the difference between these related activities before reviewing the response of the mining industry to the new legislation introduced in the 1970's to regulate the impacts of exploration and mining.

EXPLORATION

Mineral and fossil fuel deposits are non renewable and most of the outcropping resources in Australia have long since been discovered and developed.

Systematic exploration is necessary to find new deposits to maintain the supply of these essential materials. This requires access to large areas of land over which the following techniques are applied to identify indications of concealed sub surface resources.

Geological mapping is the observation and recording of rock outcrops and structures. It has no more impact than the taking of a photograph.

Geochemical surveys require the collection of small (less than 1kg) soil and rock samples for laboratory analysis.

Geophysical measurement of the magnetic, gravimetric, radio metric or electrical properties of the earth is made at spot sites with small portable pieces of equipment.

Seismic surveys require the input of impact energy and a spread of recorders to measure the response from rock formations at depth. There is no other way to detect subsurface structures likely to contain hydrocarbon reservoirs in deep sedimentary basins.

Access is required for all of these activities but only seismic surveys need heavy vehicles to carry the required equipment.

All other exploration activities can be carried out with light vehicles without the need for track construction or in sensitive areas, on foot. The few personnel involved use small portable camps only when hotel or shearer's quarters accommodation is not available.

More people would visit highly scenic areas such as the Flinders Ranges in a single day for recreation than would be engaged in mineral exploration in this area in a whole year. In contrast to tourist activities, exploration is controlled through environmental conditions imposed by Government.

Seismic surveys in South Australia are restricted to the plains of the major sedimentary basins. In prospective areas they need to be run along evenly spaced traverse lines ranging from 5 to 0.5 km apart. In the 1960's and 1970's graded tracks were prepared over even easily accessible terrain and there was some interruption to drainage and damage to vegetation and heritage items.

Since then the Government and the operators have recognised that many of the adverse impacts can be avoided and codes of environmental practice have been developed, and continue to be improved, to minimise the impacts of access for seismic surveys. However, some disturbance is necessary if future supplies of these vital energy sources are to be found.

APPRAISAL

A decision to mine cannot be made until the size, shape and mineral content of a mineral deposit is known.

Road metal and other shallow outcropping deposits require only a few test pits to provide this information.

Much more detailed investigation is necessary for larger or deeper bodies of mineralisation. In many cases the initial target of appraisal is a subsurface geophysical anomaly which may be due to geological features unrelated to a mineral deposit.

Close pattern surface drilling is the usual method of appraisal but bulldozer trenching, shaft sinking and excavation of deep trial pits are needed in some circumstances.

Access by heavy equipment is necessary but the environmental damage caused varies considerably depending on the terrain and the other natural resources on the site. A portable camp is established to accommodate the larger number of workers unless facilities already exist nearby.

In contrast to mineral exploration, appraisal of anomalies is focussed on a small area of land. Environmental damage is usually more severe until the site is rehabilitated.

Appraisal of seismic anomalies for oil and gas requires only a few widely spaced drill holes and the environmental effects are negligable after the drill site has been rehabilitated.

Appraisal rarely leads to the discovery of an economic orebody.

EXTRACTION

Production of minerals requires all or some of the following elements:

- the workings, which may be narrow diameter drill holes, underground openings or an open cut,
- a treatment plant, product stockpiles and tailings dams,
- overburden and other waste disposal areas,
- support services - offices, workshops, etc.,
- loading and transport facilities,
- power and water supply,

- workforce accommodation,

- a dewatering system.

Each orebody is unique in respect to its size, shape and depth below the surface, the surface terrain, existing land uses and the other physical resources on the site, as can be seen from comparison of a roadworks borrow pit, with the Leigh Creek coal field or a producing gas well in the Cooper Basin.

The geological characteristics of the orebody determine the mining method.

Oil, gas and other soluble minerals can be extracted from narrow diameter drill holes. The surrounding environment and land uses are unaffected except for the means of transporting the product from the well site. This is usually a sub-surface pipeline.

Narrow, steeply dipping orebodies or those with thick overburden cover have to be extracted from underground workings. Land is required for shafts, workshops and waste dumps on the surface but most of the area overlying the deposit is not affected by underground mining.

Many deposits can only be worked safely or economically by open cut. In addition to the excavation and support services, land is required for disposal of overburden unless this material can be progressively replaced within the expanding pit.

The location of the orebody and the workings needed to extract it are fixed but the other elements of the operation can be sited to minimise environmental damage.

The environmental consequences of mineral extraction are thus determined by the orebody and the terrain in which it lies. The impacts of a mine can only be determined after the deposit has been defined and the mining method selected.

Land use policies which prohibit mining before exploration and appraisal have been completed are thus inappropriate and deny the opportunity for resources to be found and worked when the environmental consequences are acceptable.

REHABILITATION

The duration of a mining operation varies from a few weeks to over 100 years. Nevertheless, mineral extraction is a temporary use of land and either the original or a new use can be established when the orebody is depleted.

Rehabilitation involves:

- removal of buildings, equipment and rubbish,
- creation of a safe and stable landform on workings, dumps and all other elements of the site,
- revegetation and drainage works to prevent water and wind erosion and to remove visual impact,
- sealing of tailings dams and other waste disposal sites to prevent water pollution and the escape of harmful substances by other means,
- management of weeds and other pests.

The objective of rehabilitation is to establish a stable ecological system free of natural processes which will cause later degration of the site and its surroundings. It does not necessarily require complete restoration of all pre-mining aspects of the site but must create an environment in which the natural diversity of species can establish without expensive long term maintenance.

MANAGEMENT OF EXPLORATION, APPRAISAL AND MINING

In South Australia minerals and fossil fuels are the property of the Crown.

Exploration, appraisal and mining can only be conducted on a tenement issued under the Mining Act, the Petroleum Act or the Petroleum (Submerged Lands) Act, except for:

1. Private Mines (approximately 300) which are excluded from the Mining Act but subject to the development control provisions of the Planning Act. Most of the major metropolitan sand and aggregate quarries are on Private Mines.

2. Council and Highways Department borrow pits which are subject to the development control provisions of the Planning Act.

All tenements which authorise disturbance of the surface or water by machinery or explosives may be subject to conditions. Detailed proposals, including an Environmental Impact Statement, are required to be lodged and assessed before any approval is given.

The main issue is not whether these activities should be allowed in a particular area but how they are to be conducted and the site rehabilitated.

The Mining Act provides for an Extractive Areas Rehabilitation Fund which levies 10 cents per tonne on all extractive minerals (construction materials) produced from mining leases and Private Mines.

Over 400 rehabilitation projects approved by the Minister have been funded since 1972 at a total cost to June 1988 of $7.2 million.

DISCUSSION

Many exploration and mining activities have little impact but these are usually unseen and unrecorded.

Public perceptions of exploration and mining are strongly influenced by the worst examples they see or read about, particularly those of the early post war period.

These perceptions are applied to new proposals, with little information about the site specific circumstances and the measures available to manage the operation.

A review of environmental management and rehabilitation activities in several major Australian mining areas recently published by AMIC (Farrel 1987) describes the successful application of modern techniques.

The environmental issues relating to exploration, appraisal and mining in three sensitive areas of South Australia are now discussed to illustrate the actual impacts which these operations generate:

1. FLINDERS RANGES

This large area of outstanding landscape value has been subject to over 100 years of continuous prospecting, exploration and mining.

Prospectors in the last century found many small outcropping copper and other base metal lodes which were worked by underground and open cut methods. Many of these, with their associated buildings, are now of considerable heritage and tourist value.

Talc and barite deposits were discovered and developed before and after World War 2 at Mt Fitton, Oraparinna and several other places. Some of the workings create significant local visual impact. Old open cuts at Moralana adjacent to a popular tourist road have recently been backfilled and others will be similarly rehabilitated as opportunities arise in the future. Despite their appearance, many of these excavations provide popular sites for mineral collectors.

While local visual impairment is acknowledged, it must also be recognised that there are only about 50 of these in the whole of the ranges and no damage to adjacent natural systems is occurring.

The whole of the ranges were subject to extensive company exploration in the 1960's and 1970's but there is little evidence on the ground of the intensive geological, geophysical and geochemical surveys conducted during this period.

Follow up appraisal was carried out at only a few sites, the most intensive work occurring in the Mt Painter area. Here an access track was constructed from Arkaroola and several steep mountain slopes extensively drilled. Natural regeneration of vegetation has covered most of these slopes and the access road is used to provide one of the most outstanding tourist experiences in northern South Australia.

The only mine to result from this period of exploration was the Puttapa zinc deposit which is a small open cut operation causing little visual or other impact.

The Leigh Creek coalfield is the largest open cut mine in South Australia supplying 35% of the energy needed for the State's electricity system. The early workings and spoil piles are unsightly but recent major extensions to the field are conducted behind a contoured embankment out of sight of the main road.

All of the roads in the ranges are constructed and maintained from locally mined materials but there is little evidence of the countless borrow pits used to build them.

A recent intensive programme of geological mapping and geochemical sampling by the Geological Survey of South Australia in the western portion of the Flinders Ranges National Park did not cause any adverse environmental impacts.

The long history of exploration and mining in this area provides a measure of the environmental consequences of these activities. Despite claims to the contrary, the facts show that mineral search and development in the Flinders Ranges has not led to widescale environmental degradation.

Although there is visual impairment in some local areas, the visitor to the ranges can drive for hundreds of kilometres without seeing any evidence of these vital activities.

2. COOPER BASIN

Exploration commenced in the Cooper Basin in 1959 and today the area is the largest onshore producer of oil and natural gas in Australia. It is a vital source of energy for Adelaide and Sydney, and has contributed over $162 million in royalty to the State since 1970 as well as being a major generator of employment and other taxation revenue.

A total of 68,000 kilometres of seismic lines have been shot and 627 wells drilled to date over an area of 214,000 km.

Some unnecessary damage has occurred from the earlier practice of grading seismic lines regardless of need but the potential for adverse impact has been significantly reduced since the introduction of new technieques and the adoption of the Codes of Environmental Practice.

The area also has a long history of pastoral occupation and tourism is now actively promoted. Regulation and supervision of these industries is negligable and hard to enforce compared with the powers of the Petroleum Act and the management activities of both the Department of Mines and Energy and the Cooper Basin producers.

3. HILLS FACE ZONE QUARRIES

Coarse aggregate for roads, buildings and other services in metropolitan Adelaide has been supplied from resources in the western face of the Mt Lofty Range since 1837.

The number and size of quarries grew rapidly during the early post war years to supply the needs of the rapidly expanding metropolitan area. New safety regulations which limited the height of working faces also caused significant enlargement of the quarry areas seen from the Adelaide Plains.

Only two new quarries have been opened since the 1970's and neither is visible from the plains.

A major public inquiry into quarrying in the Hills Face Zone commenced in 1973. The report (Environmental Protection Council 1977) recognised "the considerable benefit (derived) from access to conveniently located sources of quarrying products" but also noted that "the cost in terms of environmental damage has been substantial and far greater than necessary".

Environmental management of all but the two new operations is constrained by the existing workings which were developed before land use controls were available but realignment of faces, rehabilitation of terminal faces and screening of operations to reduce impacts is being applied as the opportunity arises.

The land containing the Tea Tree Gully quarry was purchased for reserve purposes in 1970 and work to reshape and revegetate the faces was successfully completed in 1982.

A major realignment of workings and rehabilitation of highly visible terminal faces was carried out at the largest metropolitan quarry complex, Stonyfell-Greenhill, in 1979- 1981.

Stonyfell was opened in 1837 and by the mid 1950's a working face over 100m high could be seen from a wide area of the plains. The new safety regulations limiting the height of each working face to 20 metres resulted in a large and rapid expansion of the quarry faces to maintain production. As a result Stonyfell became the epitome of all of the growing public criticism of mining which resulted in the public inquiry into Hill Face Zone quarrying in 1973.

In 1976, the Department of Mines and Energy and the company devised a plan to link Stonyfell with the adjacent Greenhill Quarry to allow new working faces to be developed behind a protective hill. Large quantities of overburden arising from this redevelopment were placed on highly exposed working faces which had become redundant as a result of the project. This material was graded, sown initially to stabilising grasses and planted

with seed and seedlings of indigenous vegetation collected from adjacent undisturbed areas of the property.

Terminal faces in the new workings are being progressively rehabilitated and in due course all faces visible from the metropolitan area will be reshaped and vegetated with local species.

SUMMARY

This paper has not been written to justify mining - the use of minerals in every fabric of society makes this unnecessary - but to provide a factual background on the activities of the mining industry.

The words exploration and mining are often used synonomously but in fact these two related activities differ in almost every respect and in particular in the area of land involved and the impacts generated.

Exploration of an area rarely leads to mining. Although the early prospectors were frequently rewarded with the discovery of an outcropping vein which could be worked, the modern explorer may spend many years in high cost systematic investigations without success.

A Petroleum Exploration Licence carries an automatic right to develop a discovery, subject to environmental and other conditions which may be imposed on a Production Licence. However, the impacts of hydrocarbon production are minor in both area and effect compared with the exploration methods necessary to find a producing field.

No automatic right to mine is attached to an Exploration Licence for minerals and coal. The Minister of Mines and Energy has discretion to grant or refuse an application for both an exploration licence and a mining (production) lease. Environmental conditions, including an obligation to rehabilitate the site, are included on every tenement now granted under the Mining Act.

Impact from mineral and hydrocarbon exploration is confined to the access requirements of the personnel and equipment needed. All techniques used, except seismic surveys and drilling, can be carried out using light vehicles or on foot. Early exploration activities caused some unnecessary damage but the extent and permancy of these impacts has not been scientifically evaluated or compared with the effects from pastoral or tourist use of the same areas. Recently introduced techniques for seismic track preparation and rehabilitation have significantly reduced the effects of these essential activities.

Every change to the use of land brings benefits and unwanted impacts. Mineral extraction is no exception but the areas of land involved are significantly smaller than those affected by urban development and agricultural expansion.

The impacts resulting from mining are site specific and depend on the orebody and the terrain in which it lies - an open cut in an area of high landscape value will create entirely different impacts to underground extraction of the same deposit and mining in the flat arid lands will have minor effects compared with the same operation at a high rainfall, mountainous site.

Thus policies which prohibit exploration and mining in sensitive areas are unrealistic because they deny the community the benefits from those deposits which can be worked to acceptable standards.

Many potential impacts are prevented or minimised by appropriate design and most of the necessary impacts can be ameliorated by rehabilitation of the site. In some cases severe local impacts are unavoidable during extraction but are outweighed by the benefits provided.

In the early post-war years, and in the absence of regulatory legislation and responsible management by some operators (including Government agencies), exploration and mining caused unnecessary damage to small areas of landscape and other natural systems.

However, the ability of Governments to impose and enforce environmental conditions on mining tenements and the response by the industry in developing successful rehabilitation techniques is ensuring that the performance of the past will not be the practice of the future.

REFERENCES

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